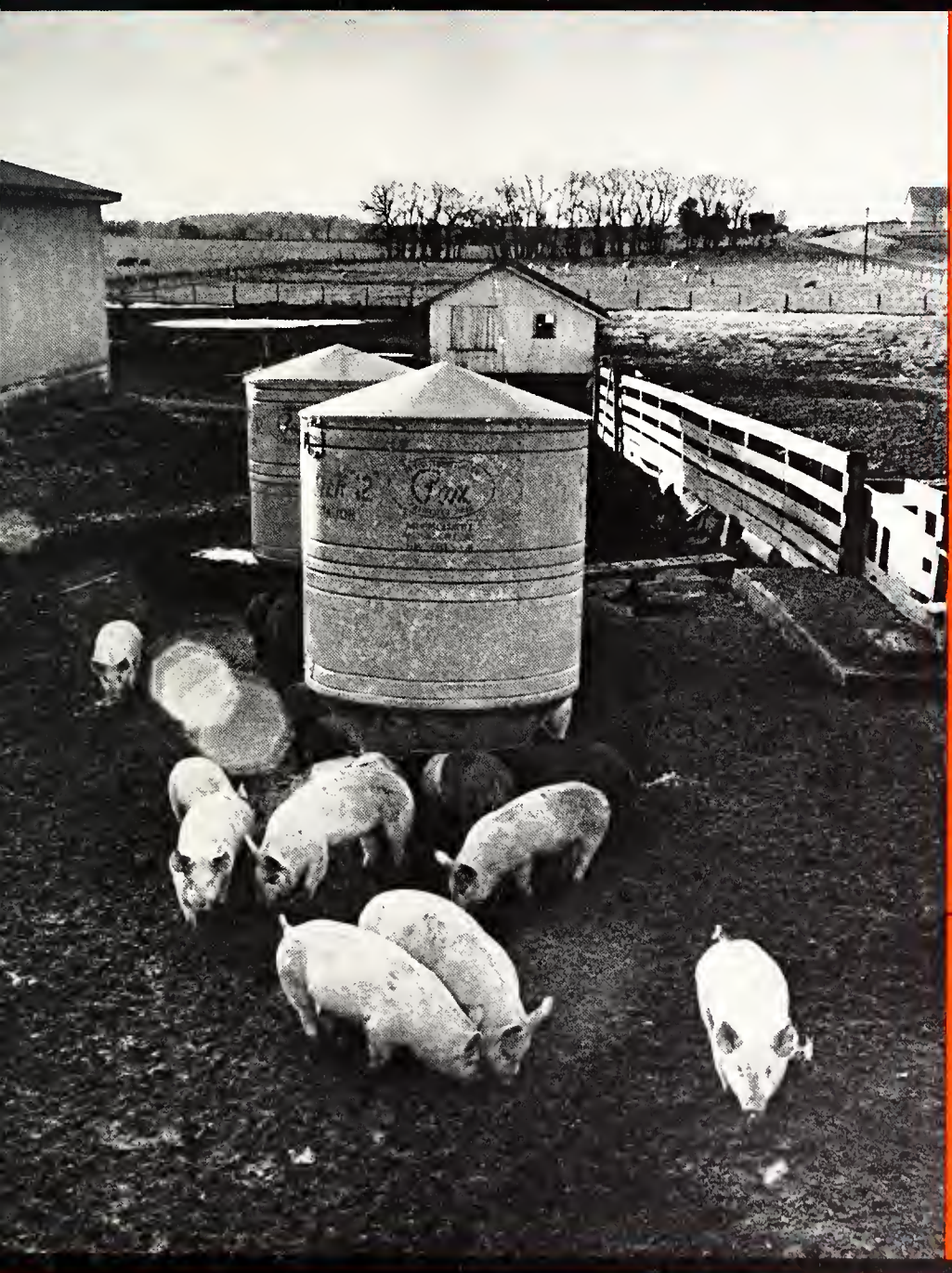
Winter, 1973

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station



IN THIS ISSUE

Hog producers can make major reductions in their feed costs by being alert to all possible discounts (page 16).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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RURAL DEVELOPMENT ACT OF 1972

THE RURAL DEVELOPMENT ACT of 1972 has the potential for remaking the face of rural America. Building upon the commitment made in the Agricultural Act of 1970 to establish a sound balance between rural and urban America, the 1972 Act encompasses many of the principal components of rural development.

Under the Act, the Department of Agriculture has the major responsibility for coordinating rural development. Several new authorities are also established to help improve rural economic opportunity and community life.

Title I of the Act consists of amendments to the Consolidated Farmers Home Administration Act of 1971. Among these are provisions for loans to establish and operate businesses and provide community facilities in rural areas; loans to rural youth; increased operating loans for farmers; and grants for pollution control.

Titles II and III contain amendments to the Watershed Protection and Flood Prevention Act and to the Bankhead-Jones Farm Tenant Act. They strengthen the ongoing Watershed and RC and D programs of the Soil Conservation Service and give new emphasis to a land inventory and monitoring program. Title IV authorizes a program for protection against wild fires in rural areas.

Title V authorizes the appropriation and apportionment of funds to states for (a) rural development extension programs, (b) rural development research, and (c) special extension, research, and development programs for the small farm. These programs, scheduled to begin July 1, 1973, and end June 30, 1976, will be administered by the Land Grant Colleges.

Title VI contains a number of miscellaneous provisions. Among them, the Secretary of Agriculture is required to coordinate rural development activities; ten-year cost-sharing payments under the Rural Environment Assistance Program are authorized; and the heads of all federal departments and agencies are directed to give priority to locating new offices and other facilities in rural areas.

Some provisions of the Act can be implemented within funding levels already provided by Congress. Several new initiatives authorized by the Act, such as Title V, will require additional appropriations before they can be implemented. — *H. J. Schweitzer, Assistant Director*

Taking an increment core from a tree at Allerton Park. The growth ring pattern of the trees in this grove reveals much about past land use practices that were never recorded by man. (Fig. 1)

Man, Land Use, and Tree Rings

S. K. SIPP and DAVID T. BELL

It is common knowledge that the age of a tree can be determined by studying its annual growth rings. Perhaps the most widely publicized tree-ring studies in this country have been those that established the great ages reached by two western species: the sequoia trees of the Sierra Nevada and the bristlecone pines of the desert mountain ranges in the Great Basin. (Some bristlecone pines have been found to be more than 5,000 years old.)

But the historical record stored in the growth rings of trees can tell us much more about a tree's life history than just its total age. Climatic conditions during the tree's life, fire history, the competition of other plants, and land use are but a few of the types of information that can be deciphered from a tree's rings. The science of studying annual growth rings to determine the date and sequence of past events is known as dendrochronology.

S. K. Sipp is Assistant Forester and David T. Bell, Forester, Department of Forestry.

How measurements are made

To measure the rings from a standing tree, a cylindrical sample of wood is taken from the tree by means of a hollow auger called an increment borer. The sample, which is about 3/16 inch in diameter, is the increment core. It is taken at right angles to the annual rings, so that one may count the rings to find the tree's age and measure their width to calculate the rate of growth for specific periods (Fig. 1).

What a ring shows

A growth or annual ring corresponds to the amount of woody tissue formed during one growing season (Fig. 2). When growth stops in the winter, this provides a line of demarcation between the thick-walled, small-diameter cells produced late in the growing season of one year and the thin-walled, large-diameter cells produced during the period of rapid growth in the following spring.

The amount of woody tissue laid down during a growing season depends upon the suitability of certain environmental factors and the ability of the tree to utilize these factors for growth. Temperature, moisture conditions, and the amount of sunlight are the environmental factors which most strongly affect the amount of woody tissue laid down each year. The ability of a tree to utilize these factors — and hence the size of the growth rings — can be greatly altered by competition from other plant species, animal activity, and the land-use policies of man.

Normally, the amount of woody tissue deposited each year gradually increases during a tree's early life. Eventually the diameter increment reaches a peak and then gradually declines. If the average diameter increment over a period of years is measured, one can smooth out annual fluctuations caused by weather changes, without masking long-term changes in growing conditions.

Trees studied at Allerton

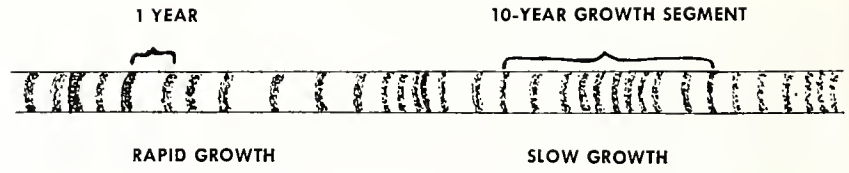
In a recent study at Robert Allerton Park near Monticello, data ob-

tained from tree rings were fused with information about past land use practices. The resulting correlations could prove helpful in establishing historical records of land-use patterns elsewhere in the region.

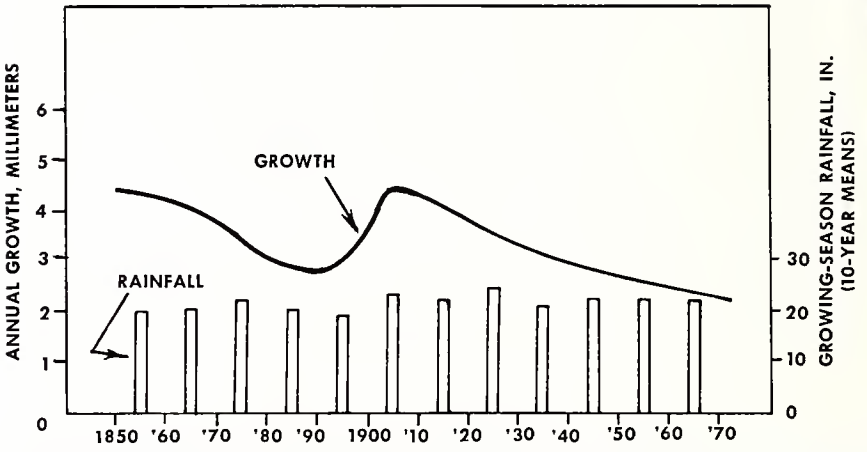
Growth rates of 21 trees ranging from 101 to 125 years of age in the northeastern part of the park were determined from increment cores taken early last spring. The 21 trees consisted of 14 white oaks (*Quercus alba*), four shagbark hickories (*Carya ovata*), two mockernut hickories (*Carya tomentosa*), and one black oak (*Quercus velutina*).

Measurement of these trees' annual rings indicated a rather unusual pattern of growth (Fig. 3). A marked decline in growth rate during the last part of the nineteenth century was followed by a period of rapid growth during the early part of the present century. During the past 50 years, the deposition of woody tissue in these trees has been typical of normal growth.

Searching the climatic data to find a cause for the abnormal growth pattern proved fruitless. Rainfall during the growing season does not appear to have been abnormally low during the 1890's, nor abnormally high from 1900 to 1920 (Fig. 3). Temperature records also fail to present a clue to the abnormal trend in diameter growth for these trees.



Representation of an increment core. Each ring represents one growing season. The length of the growth segment for every 10-year period was measured and recorded. (Fig. 2)



Growth rate pattern of trees in the Allerton Park grove, and average growing season rainfall. Growth rates are shown as average annual increases in diameter. Rainfall data were supplied by the National Oceanic and Atmosphere Administration. (Fig. 3)

Two hypotheses

Since the climatic records do not indicate any disturbances which would account for the atypical growth pattern, the activities of man are the most probable cause of the phenomenon. The data suggest two hypotheses:

One hypothesis is that the forest was logged in the 1850's and that it was then grazed until the middle or late 1890's. Compaction of the soil by cattle, causing incomplete aeration of rooting zones, would lead to a decrease in growth rates. Relieving the grazing pressure would allow the return of a normal tree growth pattern over a period of time.

The second hypothesis is that a virgin forest existed until the mid-1890's, when selective logging was done. The slowing growth curve would be the response of under-story saplings to the small amount of light coming through a closed forest canopy. If the larger trees of the grove were selectively cut, the increased light reaching the saplings would give rise to the rapid growth in the early 1900's.

In either case, the absence of trees older than 125 years suggests that the area had been logged.

Historical records supplement data

For help in deciding between the two hypotheses, we consulted with Dr. Walter M. Keith, Director of Allerton Park, and Mrs. Elizabeth M. Hanson, an expert on the settlement period of Piatt County. From them we learned some interesting facts about the county's history.

According to original surveyor's notes, most of the Sangamon River valley was forested when the white man began to settle in the county. The first land sales were made in the middle and late 1830's, and Samuel Allerton began buying the land in and near the present Allerton Park in the 1850's. The grove being studied was acquired between 1876 and 1896.

In 1896 Samuel Allerton, while retaining some of his acreage, deeded parcels of land to his son Robert and his daughter Kathleen. At about the same time, Robert Allerton took over management of the estate and eliminated grazing and logging.

Putting together the historical record and the record in the trees' rings, we decided that the second hypothesis fit the facts better than the first one. The area was probably logged just before it was deeded to Robert Allerton. The residual saplings filled in the canopy and are now the dominant trees in the grove. Further research into written records may more closely determine the exact cause of the altered growth.

In this instance, historical records helped us to interpret the records found in tree rings. In many other situations, tree ring analysis may be a useful tool for elucidating gaps in the written history of Illinois.

Problems in the Utilization of Hardwood Residues

Large amounts of hardwood residues are left over from Midwestern pulping, lumbering, and milling industries. Since this material can no longer be burned or dumped, efforts are being made to utilize it as particleboard, as well as in other ways. The manufacture of particleboard presents problems, however, two of which are discussed below.

Particleboard Tested For Fire Resistance

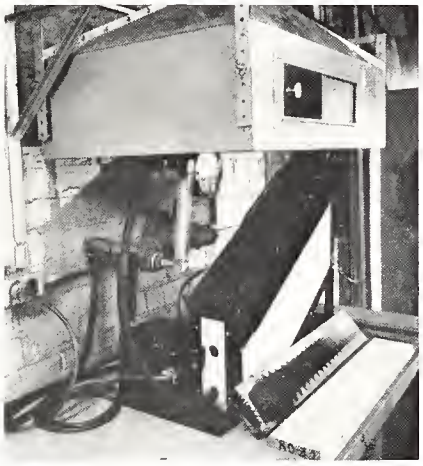
CITY BUILDING CODES often limit or prohibit the use of panel boards that burn. Asbestos board is fireproof, but boards made of cellulosic fibers, such as hardboard, plywood, or particleboard, will burn unless they are made flame-resistant.

The Forestry Department's research on converting plant residues to useful products will include the study of how to make particleboard panels flame-resistant. In some cases, fire-retardant paints or coatings will be tested. Some boards will be impregnated with chemicals applied under pressure, or the chemicals will be mixed with the furnish before the fiber mat goes into the hot press.

A recently acquired two-foot tunnel-tester is being used in the studies. Samples of panels about 4 inches wide by 24 inches long are put into the tester at an angle of 28 degrees from the horizontal. The test flame, obtained from a burner similar to a Bunsen burner, is imposed on the lower end of the test specimen. Methane gas is supplied to the burner at a constant rate to eliminate differences in heat energy.

The test specimen is exposed to the flame for 5 minutes. During the first 4 minutes, the advance of the flame front up the inclined panel is measured at 15-second intervals. The results of the tests with particleboard will be compared with those for red oak and asbestos-cement panels.

Since smoke often is the principal hazard to life, it, too, will be evaluated. — *C. S. Walters, Professor of Wood Technology and Utilization*



The two-foot tunnel tester.

Measuring the pH Of Hardwood Bark

WHEN BARK is going to be made into particleboard, its degree of acidity or pH is important, since the pH may affect the curing rate of the urea-formaldehyde adhesive that is normally used. This adhesive should be cured under acidic conditions.

To date there is no standard method for determining the pH of wood. However, in quality-control and industrial research, cold- or hot-water extracts are made of cellulosic materials, and the pH of the extracts is measured.

Although hot-water extraction results in more accurate pH measurements than cold-water extraction, it takes more time. A study was therefore undertaken to determine whether cold-water extraction could be used to obtain a reasonably accurate measurement of bark pH.

Barks from a species of white oak, a species of red oak, cottonwood, and black walnut were collected from Illinois wood-using industries. Random samples of hammermilled barks were passed through a Wiley mill to obtain 40-mesh particles.

For hot-water extraction, 2 grams of the ground particles were mixed with 50 milliliters of boiling distilled water. After a 30-minute cooling period, the pH was measured with a standardized pH meter. For cold-water extraction, the same procedure was followed except that cold distilled water was substituted for the hot water. Five replicate measurements were made for barks of each species by both extraction methods.

The categories developed by Buckman and Brady were used to classify pH values: a pH of 4 to 5 was considered strongly acid; 5 to 6, moderately acid; 6 to 7, slightly acid; 7 to 8, slightly alkaline.

The barks ranged from strongly to slightly acid, as shown by the following pH values:

Bark type	*Cold-water extraction*[a]	*Hot-water extraction*[a]
Red oak	4.87	4.72
White oak	5.25	5.13
Cottonwood	5.58	5.45
Black walnut . . .	6.03	6.00

[a] Each value is an average of five measurements.

Walnut bark was lowest in acidity. If it or another low-acid bark is used with an urea-formaldehyde adhesive, then an external catalyst should be added or the press cycle lengthened for complete cure of the adhesive.

Regardless of species, hot-water extracts had slightly, but significantly, lower pH values than cold-water extracts. This was probably because hot water dissolved more acidic extractive materials than cold water. However, the differences were all less than 0.2 pH unit. For practical purposes, therefore, cold-water extraction is a suitable method for measuring the pH of hardwood bark materials that are to be bonded into particleboard. — *Poo Chow, Assistant Professor of Wood Science*

How the Weather Affects Corn and Soybean Yields

E. C. A. RUNGE and S. G. CARMER

AGRICULTURISTS often ask themselves what combination of soil and weather conditions will produce the best yields of corn and soybeans. A second question is also frequently asked: What proportion of the yield variation between two locations is due to weather, and what to soils?

The yield comparisons reported here should help to answer these questions, at least for average weather conditions. To make our comparisons, we did not grow corn and soybeans at many locations for many years. Instead, we developed equations relating yields of corn and soybeans at Urbana to average rainfall and maximum daily temperatures at other Illinois locations.

The equations were derived from long-term yield studies on the Agronomy South Farm, Urbana. Corn yields had been recorded for 54 years; soybean yields, for 49 years. Rainfall and maximum temperatures during the growing season were found to account for 67 percent of the yearly variation in corn yields and 68 percent of the variation in soybean yields.

The crops were grown on Drummer and Flanagan soils, some of the best soils in the Corn Belt. The results reported here for the 24 stations outside of Urbana are as if each location had these soils. Clearly this assumption isn't true, but it does allow us to see how average weather conditions at different locations affect yield. Consequently, we can separate weather effects from soil effects.

Weather records were supplied by the Illinois State Water Survey. The record length varied from about 50 to 70 years at the different stations. After determining the average rainfall and average maximum temperatures for the intervals needed in our equations, we calculated yields at each location. We used two equations for corn and one for soybeans.

E. C. A. Runge is Associate Professor of Soils; S. G. Carmer is Professor of Biometry, Department of Agronomy.

64-day model for corn

The most reliable corn yield equation utilized a 64-day period including 50 days before and 14 days after pollination. Equations were worked out for five planting dates and the weather data were varied accordingly. May 16 was considered the normal planting date. April 27, May 7, May 25, and June 3 were the other assumed planting dates. Yields at all locations were compared to the Urbana yield for each planting date and are recorded as percentages of the Urbana yield (Fig. 1a to 1e).

The greatest variation in yield due to differences in weather conditions was found when a May 7 planting was assumed (Fig. 1b). Yields throughout the state ranged from +5 to −11 percent of the Urbana yield. The least variation in yield due to weather variation was found with a June 3 planting, when yields ranged from +5 to −3 percent of the Urbana yield. Generally the weather is more favorable for corn in northern Illinois and less favorable in southern Illinois than it is at Urbana.

96-day model for corn

The second model for relating corn yield to rainfall and daily maximum temperature utilized the 96-day period from May 20 through August 23. Since this model was a fixed calendar period, only one yield was calculated for each location (Fig. 2).

Effect of Planting Date on Corn Yield as Influenced by Rainfall and Temperature (May 16 planting = 100 percent)

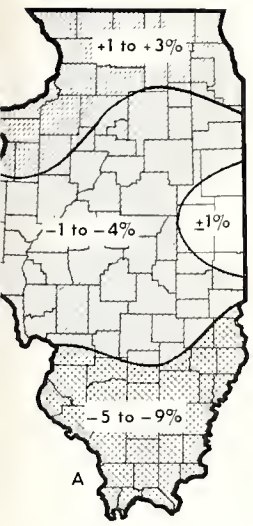
Station	Planting and pollination dates			
	4/27, 7/9	5/7, 7/17	5/25, 8/2	6/3, 8/10
	pct.	pct.	pct.	pct.
Freeport	107.1	103.9	96.8	98.0
Marengo	107.3	103.6	98.8	95.6
Dixon	106.9	102.8	98.0	96.4
Aurora	107.4	104.1	99.1	99.1
Galva	108.2	102.8	98.7	98.9
Ottawa	107.4	100.8	96.9	97.2
Kankakee	107.8	103.0	99.7	102.3
Bloomington	109.1	102.0	98.5	99.1
Havana	110.4	103.4	98.7	98.6
Danville	109.9	102.3	97.4	96.7
Urbana	107.0	103.0	97.6	96.5
Quincy	111.0	103.2	99.7	100.2
Jacksonville	109.7	101.3	98.6	99.8
Decatur	111.9	103.4	99.2	99.7
Charleston	107.2	103.5	98.7	97.8
Carlinville	113.5	104.2	99.7	99.5
Effingham	108.2	100.3	100.7	99.4
Palestine	108.0	102.6	99.8	101.2
Greenville	110.3	102.3	99.9	100.6
St. Louis	106.1	102.8	103.9	104.7
Mt. Vernon	111.7	101.5	102.2	105.4
DuQuoin	108.9	102.0	102.1	104.2
Harrisburg	106.4	98.9	100.1	106.6
Anna	107.5	100.0	103.0	103.4
Cairo	105.1	101.0	101.6	103.5
Aver.	108.56	102.35	99.58	100.18

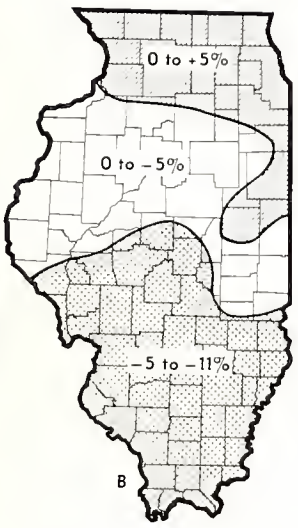
The variation in yield within the state due to differences in weather conditions ranged from +5 to −15 percent of the Urbana yield. The most favorable weather for corn is again in northern Illinois and the least favorable in southeastern Illinois. However, a large portion of central and western Illinois has less favorable weather for growing corn than does Urbana.

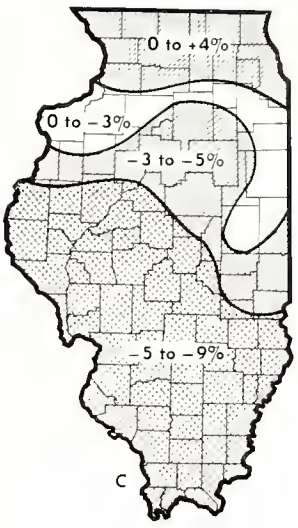
Effect of planting date

During recent years agronomists have encouraged the early planting of corn. Most of the increased yield from early planting has been attributed to increased day length. The equations used in our study enabled us to determine whether some of the increase in yield is due to more favorable weather conditions.

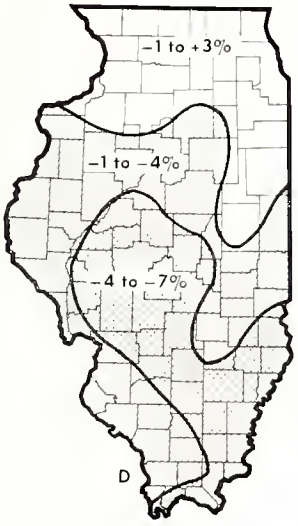
Using the 64-day model, we determined whether rainfall and maximum temperature for early and late planting dates were more or less

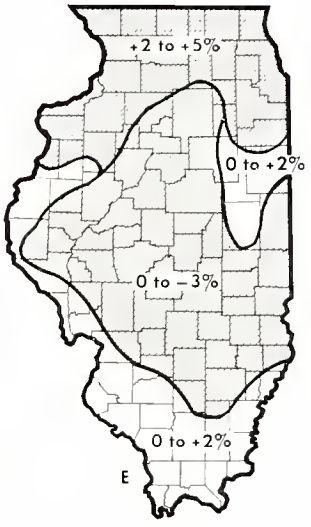


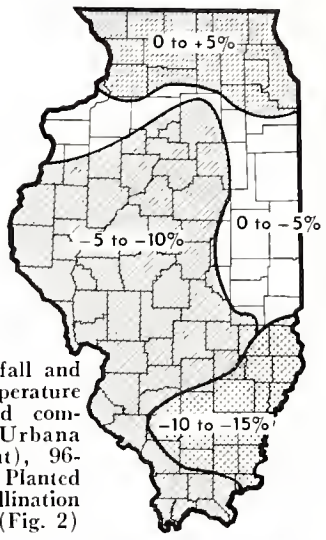




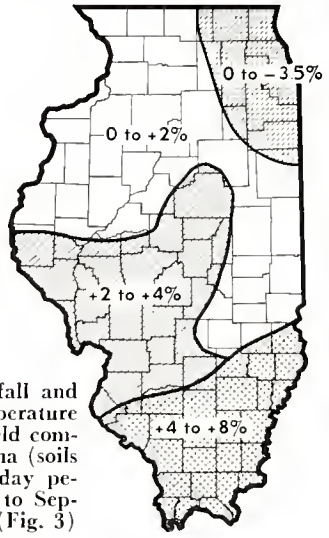
Effect of rainfall and maximum temperature on corn yield compared to Urbana (soils constant), 64-day model. A, planted April 27, pollination July 9; B, planted May 7, pollination July 17; C, planted May 16, pollination July 25; D, planted May 25, pollination August 2; E, planted June 3, pollination August 10. (Fig. 1)







Effect of rainfall and maximum temperature on corn yield compared to Urbana (soils constant), 96-day model. Planted May 16, pollination July 25. (Fig. 2)



Effect of rainfall and maximum temperature on soybean yield compared to Urbana (soils constant). 88-day period, June 25 to September 20. (Fig. 3)

favorable than for a May 16 planting date at each location. The results were expressed as percentages of the yield obtained with planting on May 16 (see table on page 6.)

According to our results, the higher yields that have been found for earlier planting dates are due partly to more favorable weather conditions. With the April 26 planting date, rainfall and maximum temperatures would account for yields 108.6 percent of those for a May 16 planting date; with a May 7 planting date, yields would be 102.4 percent. Such increases would occur rather consistently for all locations in the study (see table).

The yields for May 25 and June 3 planting dates are lower than for the May 16 planting date north of Urbana; and nearly the same or higher south of Urbana. South of a line running east from St. Louis, average rainfall and maximum temperatures would give substantially higher yields for a May 25 or June 3 planting date than for May 16 planting.

Soybean yields

Our research relating soybean yields to rainfall and maximum temperatures is less complete than for corn. So far, we have worked with only one model — an 88-day model, extending from June 26 to September 20 (Fig. 3).

Results for soybeans are quite different than those for corn. The poorest weather for growing soybeans occurs in northeastern Illinois; the most favorable weather, in southern and western Illinois.

Expanded study

In the future we expect to expand our study to include the area from eastern Kansas and Nebraska to Indiana. We are also expanding our models to include the effects of varying amounts of plant-available moisture stored in the soil, as well as rainfall and maximum temperature.

Nutrient Intake of University Students

F. N. OWENS

Although most Americans can afford to eat well, many of us don't do so. In fact, it has been estimated that four out of five adults consume a daily diet that is deficient in one or more of the essential nutrients.

To learn something about the adequacy of college students' diets, we asked 66 students in the College of Veterinary Medicine to record 24-hour food intake on randomly selected days during February, 1971. Most of the students lived in private residences and did not eat dormitory meals.

Using tables giving the nutrient contents of the foods consumed, we calculated total intake of 13 nutrients. The proportions of animal products, plant products, and 12 common foods in the diet were also recorded.

Table 1. — Nutrient Intake Compared With Dietary Allowances

Nutrient	Mean intake	Estimated allowance, RDA[a]	Student intake		
			Below RDA	Below 50% of RDA	Over 150% of RDA
			percent of students		
Energy, kcal	2561 ± 1059[b]	2800M-2000F[c]	60	6	9
Protein, g	118 ± 53	60M-55F	9	0	68
Calcium, g	1.06 ± 0.64	0.8	45	6	29
Phosphorus, g	1.71 ± 0.87	0.8	9	2	71
Sodium, g	2.71 ± 2.07	...	..	..	..
Potassium, g	2.74 ± 1.20	...	..	..	..
Iron, mg	17.8 ± 7.1	10M-18F	11M-78F	2M-11F	69M-22F
Vitamin A, IU	5419 ± 6024	5000	65	32	20
Vitamin C, mg	95.4 ± 80.6	60M-55F	41	24	50
Thiamin, mg	1.62 ± 0.99	1.4M-1.0F	41	8	22
Riboflavin, mg	2.29 ± 1.16	1.6M-1.5F	26	6	48
Niacin, mg	20.8 ± 11.3	18M-13F	44	3	30
Cholesterol, mg	448 ± 360	500 max[d]	67	41	23

[a] Recommended dietary allowance for males and females 18 to 22 years of age, National Research Council, 1968. [b] Range about mean to include 68 percent of observations. [c] M for males and F for females. [d] Restriction of cholesterol intake to this maximum has been recommended.

Intake of nutrients

The first two columns of Table 1 show that the students' mean daily intake of all nutrients except energy was at least as great as the recommended dietary allowance (RDA). So the "typical" student is adequately nourished. However, the large range in intake suggests that some students may not be meeting their daily quotas. This is confirmed in the fourth and fifth columns, which show the percentages of students with intakes below the RDA and less than half the RDA.

Energy. Although energy intake appears to be too low, most students maintained a constant weight during the semester, indicating that energy was not really deficient. The sedentary life of a student would reduce energy output, making the RDA figures an overestimate of true energy needs.

Protein intake was adequate, reflecting the high consumption of animal products in our society.

Minerals. Surprisingly, many students didn't get enough calcium. Calcium intake is closely tied to milk intake, as indicated by an r value of .84. (The r value reflects closeness of relationship, with 1.0 being a perfect correlation.) Most students got enough phosphorus from the large amounts of meat consumed.

No recommended dietary allowances have been set for sodium and potassium, because these minerals are rarely deficient. The students' potassium intake approximated their sodium intake, which is the usual pattern. Potassium intake also parallels protein intake ($r = .85$) since it is found primarily with protein. Iodine was not measured, but the use of iodized salt is recommended. A recent decline in the use of iodized salt has increased the incidence of goiter.

Iron is the only monitored nutrient for which women have a higher requirement than men. Of the nine women in the study, seven got less iron than is recommended. Whether the recommendation is too high is debatable. Nevertheless, anemia affects some 15 percent of the population and is reported to be higher among women than among men. Adding more iron to flour has been suggested to alleviate this problem.

Vitamins. The nutrient for which subnormal intakes were most frequently recorded was vitamin A. Yet daily intake varied greatly. Since large amounts of this vitamin are stored by the liver, it need not be supplied daily. Therefore, weekly or monthly intake would provide a better index of sufficiency. Although excessive supplemental doses of vitamin A may be injurious, intake of foods rich in this vitamin should be encouraged.

Vitamin C intake was also low for many students. Since this vitamin is stored less readily than vitamin A, daily intake is suggested. Whether the 2,500 mg daily intake suggested by Linus Pauling is superior to the 55-60 mg recommended in the United States or to the 20 mg prescribed in Great Britain has not been proved. However, since about one out of four students consumed less than 50 percent of the U.S. recommended level, supplemental vitamin C might

F. N. Owens is Assistant Professor of Animal Science.

Table 2. — Intake of Specific Items

Item consumed	Pct. consuming	Mean daily intake	
		Consumers	All students
Meats			
Beef	88	212 grams	186 grams
Pork	32	97 grams	31 grams
Poultry	14	356 grams	50 grams
Other foods			
Breakfast cereal	26	1.5 bowls	0.4 bowl
Eggs	24	2.4 eggs	0.6 egg
Beverages			
Milk	83	2.5 glasses	2.1 glasses
Coffee	24	2.4 cups	0.6 cup
Orange juice	38	1.8 glasses	0.7 glass
Beer	17	3.5 glasses	0.6 glass
Nutrient pills			
Vitamin	26	1 pill	0.26 pill
Mineral	12	1 pill	0.12 pill
Lecithin	6	1 pill	0.06 pill

Table 3. — Dietary Supplements and Nutrient Intake

	Calcium	Phosphorus	Iron	Vitamin A	Thiamin	Riboflavin	Niocin	Vitamin C
	Average dietary intake							
	gr	gr	mg	IU	mg	mg	mg	mg
Mineral pill consumers	0.98	1.82	18.1	..	..	..	..	..
Vitamin pill consumers	..	..	..	3833	1.84	2.63	15.4	92.5
Nonconsumers of pills	1.07	1.69	17.8	5969	1.54	2.17	22.6	96.4
	Percent of students below RDA							
Mineral pill consumers								
Not including pill	50	38	12	..	..	..	..	..
Including pill	50	38	0	..	..	..	..	..
Vitamin pill consumers								
Not including pill	..	..	..	82	41	29	65	29
Including pill	..	..	..	6	6	0	12	6
Nonconsumers of pills	44	5	21	59	41	25	37	45

well be beneficial. The relationship of orange juice intake to vitamin C intake ($r = .73$) indicates one rich source of this vitamin.

Intake of several B-vitamins (thiamine, riboflavin, and niacin) was low among a sizable group of students. But again, the requirements are not firmly established. All three parallel protein intake ($r = .31, .63, .65$, respectively), with riboflavin being also closely correlated to milk intake ($r = .70$).

No deficiency symptoms. Only 6 percent of the students met requirements for all nutrients on the days that records were kept. However, none of the students showed deficiency symptoms. The recommended requirements may be too high, especially since individuals differ in nutrient needs. Also, with variable daily intakes, storage of nutrients in the body may stabilize nutrient conditions and prevent actual deficiencies.

Cholesterol

High levels of cholesterol in blood have been associated with atherosclerosis, and are often attributed to dietary fat or cholesterol. Some physicians recommend diets containing less than 250 mg of cholesterol a day to correct high blood cholesterol. Yet cholesterol is manufactured in the liver when not provided in the diet. A recent federal survey suggests that blood cholesterol levels are at least as closely related to total energy and fat intake as to cholesterol intake.

Over one-third of the students had intakes below 250 mg, although one in ten had daily intakes over 1,000 mg, largely from egg and poultry consumption.

Food, beverage, and pill intakes

The students' total meat consumption (Table 2) differed slightly from the 1972 national per capita averages of 114 pounds of beef, 72 pounds of pork, and 48 pounds of poultry. Most of the group consumed some type of beef, often in the form of processed meats or hamburger, but only one in three had pork and about one in seven had poultry on the day of the survey. Yet when poultry was served, it made up a larger proportion of the total meal than did beef or pork. This may be associated with the limited use of poultry products in processed foods and the difficulty of preparing single servings.

About one in four students consumed cereal, mainly of the dry type, and about one in four had eggs. Students eating eggs usually had more than one, but egg intake figures do not include eggs used in baked foods, which may be the reason for an egg intake below the U.S. average of 0.9 egg per day.

Judging by quantity consumed, beer was the most popular beverage among the students who drank it at all. Yet five times as many students drank milk during the day. Surprisingly few students drank coffee.

As products of our pill-taking society, some students supplemented their diets with vitamin, mineral, or lecithin pills. Among those taking mineral pills, a higher percentage were below the RDA for dietary calcium and phosphorus than was true of the group not taking pills (Table 3). However, the pills were usually of the wrong composition to change apparent nutrient status.

Students taking vitamin pills recorded lower dietary intakes of vitamin A and niacin than the rest of the class. The "shotgun" treatment with vitamins was usually more than adequate to raise total intake of vitamins above the RDA.

Other observations

A high proportion (86 percent) of the students ate breakfast. Those eating a big breakfast were likely to skip their noon meal, but always had a large evening meal. This meal usually provided most of the day's energy, accounting for 47 percent of average daily caloric intake.

Following the same pattern observed in the U.S. population, the students obtained about 20 percent of their calories from protein and about 40 percent each from carbohydrate and fat. Finally, about half their food and energy intake came from animal products, reflecting the tastes of our affluent society.

A Silent Thief in the Feedlot

Although bovine coccidiosis robs Illinois beef producers of more than a million dollars every year, cattlemen do not generally recognize the seriousness of this disease

PAUL R. FITZGERALD and MANFORD E. MANSFIELD

Poultry raisers recognize coccidiosis as a major disease problem, but cattlemen generally do not realize that it is a serious disease in cattle as well. Coccidiosis also affects other classes of animals, especially sheep, dogs, and cats. Although it is found in wild birds and animals, little is known about losses which may occur in nature.

Coccidiosis is not limited to any particular environment, but may occur anywhere throughout the tropical and temperate zones of the world. Outbreaks among Illinois cattle have been reported by veterinarians and Extension advisers.

Unfortunately, neither the Illinois State Department of Agriculture nor the U.S. Department of Agriculture considers coccidiosis a "reportable" disease. Figures as to the losses from bovine coccidiosis must therefore be based on rough estimates. Losses in the United States in 1971 can be placed at about 47 million dollars. The loss to Illinois growers probably runs in the neighborhood of 1.2 million dollars a year.

The College of Veterinary Medicine has been studying animal coccidiosis for several years. Recently emphasis has been directed toward the study of bovine coccidiosis at the Dixon Springs Agricultural Center. Experimental work done there has given information on severity of the disease, prevention, and economic losses.

Nature of the disease

Cattle are known to be affected by 21 species of coccidia, most of which are host-specific. Of these 21 species, only *Eimeria bovis* and *E. zuerni* are important in the United States, with *E. zuerni* tending to cause the most severe infections. Both species occur in herds throughout the country in about 35 percent of the animals. Their presence makes outbreaks of coccidiosis possible in any herd at any time.

Although coccidiosis may occur at any time of year, it often strikes when humidity is high and temperatures are warm. An important exception is "winter" coccidiosis, which occurs in winter, when temperature and humidity are comparatively low. Significant outbreaks are most likely to occur north of the fortieth parallel.

Coccidiosis in cattle is usually insidious, becoming evident only after an animal has developed severe diarrhea and gone off feed. Food and water consumption declines markedly during the active stage of the disease. The result is a loss in weight, especially from the third to the eighth week after infection.

Severely affected animals may die slowly as a result of the diarrhea, dehydration, loss of appetite, loss of weight, general weakness, and loss of vigor. Death usually occurs quietly after a comatose period. Some animals may develop pneumonia when they become too weak to move about. They may die of the pneumonia, but the initial cause was coccidiosis.

Infections begin in the tissues of the ileum, or lower small intestine, which the causal parasites invade after they are ingested by the animal. As the cycle develops, infection moves into the lining, or epithelium, of the cecum and large intestine, severely damaging this tissue. With the exposure of capillaries and other small vessels, blood is lost into the intestine, causing the bloody diarrhea that characterizes the disease. As the intestine is denuded of its epithelium, it loses its ability to absorb water. Dehydration follows and general physiologic functions are altered.

Recovery is slow

Not all severely affected animals die. However, it takes them a long time to regain their vigor. While they are recovering, tail heads, rumps, and hind legs become soiled with blood and feces which serve as sites for fly larvae invasion during warm weather. Sphincter muscles controlling the anal opening may become relaxed (or temporarily paralyzed), allowing flies to deposit their eggs in the rectum.

Severe infection retards the growth of surviving animals. It usually takes about 6 to 13 weeks after infection for food and water consumption to return to normal. The animals may then start gaining at about the same rate as uninfected animals, but not enough to recover their loss of weight during the normal growing period. At Dixon Springs, yearling cattle that had been severely infected when 2 months old were as much as 95 pounds lighter than uninfected controls at the end of an 11-month experimental period.

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Animals that survive a moderate to severe attack of coccidiosis usually develop resistance to further attacks by the same species of coccidia.

Therapeutic treatment

In late stages of an infection, administration of drugs to kill the parasite is mostly ineffective because the damage to the intestine has already been done, and no compound can restore destroyed tissue. Therefore, therapy of the severely diarrheic calf is mostly supportive. Intestinal disinfectants such as sulfonamides, antibiotics, astringents, and antidiarrhetic compounds or demulcents may be given to support the affected animals.

Fluids containing electrolytes, proteins, vitamins, and carbohydrates can sometimes save the lives of animals. These fluids may be given orally, rectally, intravenously, or intraperitoneally.

Animals that have lost a great deal of blood are often given blood transfusions. However, transfusions may do more harm than good because the excess of anticoagulant given with the blood causes renewed bleeding in the intestine.

Preventive treatment

As with other communicable diseases, the primary problem is to prevent the spread of infections between animals within the herd as well as between herds. Trials have been conducted to determine whether coccidiosis can be prevented or controlled in cattle, as it is in poultry, by giving various compounds in feed or water.

A number of drugs, chemicals, and antibiotics that are effective against the early stages of the parasite have been tried with cattle. However, the U.S. Food and Drug Administration has cleared relatively few compounds for use in the control of bovine coccidiosis. Of those that have been cleared, sulfa drugs are among the most effective. The antibiotic monensin and the drug amprolium appear to be among the most promising of the materials now being tested for the prevention and control of coccidiosis.

These two calves are the same age. The one on the left (calf 16) was severely affected by coccidiosis, while calf on the right (calf 1) was an uninfected control.

Current studies at Dixon Springs are designed to determine whether calves can be immunized against severe outbreaks by giving them feed that contains both infective organisms and coccidiosis-controlling compounds. "Controlled" infections may allow animals to develop a natural immunity.

Cost of prevention

Coccidiosis-controlling compounds have not been incorporated into cattle feeds as they have into poultry feeds, mainly because the cost is said to be too high. This objection is not justified, however, as indicated by the following figures:

A 4-pound broiler may have a market value of about 15 cents a pound, or 60 cents. An average bird will eat about 9.6 pounds of feed to reach that weight.

A feeder steer is marketed at about 1,000 pounds at a price of about 35 cents a pound or $350. A 1,000-pound steer would thus have about the same value as 583 broilers weighing 4 pounds each. The 583 broilers would require about 5,600 pounds of feed to reach marketable size; the steer, 6,500 pounds of dry feed.

The cost of medication in poultry feed is about $2 to $2.50 per ton of feed. A similar cost could be assumed for medicating cattle feed. Medication for preventing severe coccidiosis would cost $6.50 to $7.80 for a 1,000-pound steer, as compared with $5.60 to $6.70 for 583 broilers. The cost for steers could likely be reduced because it would not be necessary to continue medication for an entire year if animals were properly immunized.

Value of One Steer vs. Value of 583 Broilers

	One broiler	583 broilers	One steer
Lb. feed required...	9.6	5,600	6,500
Market wt., lb.....	4	2,332	1,000
Value, dollars	0.60	350	350
Ratio of feed consumed to lb. of gain	...	2.4:1	6.5:1

It now appears that if medicated feed is feasible for poultry, it is also feasible for cattle, particularly where outbreaks are frequent. Current studies are aimed at developing a practical method of immunizing feeder calves going into the feedlot. At present there is no way to precondition calves against coccidiosis. The stress on the calf going into the feedlot is often important in the overall feeding program. Efficient control of coccidiosis could help reduce stress and improve the general health of feedlot animals.

Battling the Soybean Cyst Nematode

R. B. MALEK and D. I. EDWARDS

In the continuing war of man against worm, the soybean cyst nematode has been winning some important battles. This pest (known as *Heterodera glycines* scientifically and as SCN for short) is of ever-increasing importance to the U.S. soybean industry. In southern Illinois, SCN may become the number one limiting factor to soybean production.

Geographical spread

SCN has defied strict federal and state quarantine regulations designed to prevent its spread. It is slowly increasing its geographical range not only into new states but also within Illinois. West of the Mississippi River, the nematode is present as far north as Pike County, Missouri. This is only some 30 miles farther south than Champaign County, Illinois, the heart of the state's soybean industry.

First detected in Illinois in Pulaski County in 1959, SCN appeared to bring its northward movement to a halt in 1967 in Franklin County (Fig. 1). During 1972, however, infestations were discovered farther north, in Jefferson, Washington, and White counties. SCN now occurs in 12 counties in southern Illinois.

Just how SCN continues to get around, despite quarantine regulations, is a matter of conjecture. Although inadvertant transfer by man was thought in earlier years to be the major means of spread, wildlife is now becoming a prime suspect. For instance, it is now known that blackbirds feeding in infested fields pick up and carry live cyst nematodes in their digestive tracts. Almost all forms of wildlife with soil adhering to their bodies are potential carriers of cysts.

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Symptoms are sometimes dramatic

During the first part of the 1972 growing season, a peculiar set of conditions occurred in counties with new infestations, as well as in counties where SCN had previously appeared. These conditions were: (1) previously undetected but rapidly increasing populations of *Heterodera glycines,* (2) drouth following soybean emergence, and (3) an unusually high incidence of *Rhizoctonia* root rot. In addition, SCN-infected roots were frequently devoid of nitrogen-supplying bacterial nodules. This combination of factors resulted in large areas, frequently several acres in size, of brilliant yellow, severely stunted soybeans. In most cases, growers had noticed nothing abnormal about their beans during the 1971 season.

The dramatic symptoms of SCN damage frequently observed in 1972 do not commonly occur in Illinois with its predominantly heavy fertile soils. Only when root infection is accompanied by severe stress from other causes does the nematode make its presence so obvious.

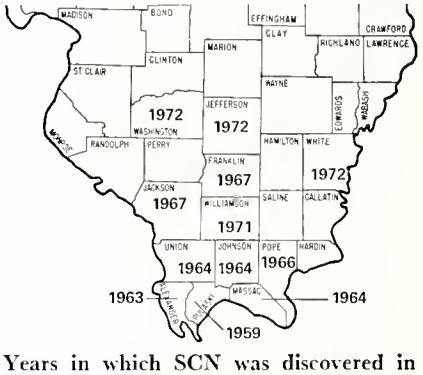
Usually, badly infested areas in a field show up as relatively small, round to oval pockets of stunted plants having a general yellowish cast with the most severe damage in the center (Fig. 2). By carefully lifting plants and shaking roots free of soil, one can see the minute white, yellow, or brown spherical females, somewhat smaller than a pinhead, attached to the roots.

Drastic cutbacks in funds have severely limited federal and state surveys for detection of SCN. Growers, particularly in peripheral areas outside of known infestations, should therefore be on the lookout for signs of the nematode's presence. A suspicious area should be reported to the county Extension adviser at once so that the nematode's presence can be confirmed. The sooner SCN is detected, the sooner the grower can initiate steps to control the infestation and to prevent its spread to uninfested acreage.

SCN breaks varietal resistance

The use of resistant soybean varieties is still the most practical means of combating SCN in Illinois. However, the nematode has found a way to circumvent this weapon. Populations are adapting themselves to all known resistant varieties. In many areas of Missouri, Tennessee, and Arkansas, even resistant soybeans can no longer be grown without sustaining severe damage because of these resistance-breaking populations, collectively known as SCN Race 4.

Race 3, which does not damage resistant soybeans, is still the predominant form of SCN in Illinois, according to recent studies by the University. However, Race 4 was detected in a field population from Massac County. It increased to damaging levels in the greenhouse in only two soybean croppings. This indicates that Race 4 is probably building up in areas where SCN has existed for a number of years. Resistant soybeans, if grown continuously in the same field, may well sustain damage in the southern tip of Illinois in the near future.



Years in which SCN was discovered in southern Illinois counties. (Fig. 1)

SCN damage usually shows up as oval patches of yellowed, stunted plants. (Fig. 2)

Of the four available resistant varieties, only Custer (Maturity Group IV) is adapted to southern Illinois, although some Dyer (Group V) has been successfully grown in the extreme southern tip of the state. The value of growing Custer on land heavily infested with SCN is illustrated in the table below. However, this variety will not normally outyield susceptible varieties on uninfested land. Furthermore, because of its longer growing season, Custer will not be a dependable variety in the northernmost counties of SCN infestation.

The U.S. Department of Agriculture and state agricultural experiment stations are attempting to develop varieties that are resistant to both Races 3 and 4 and that can be grown farther north than the present resistant varieties. Since these new varieties will not be available for several years, crop rotation with nonhost corn or small grains is the only suitable alternative. The nematode has not yet been able to counterattack on this front. However, because eggs can survive in the cyst for some time in the absence of a host plant, at least a three-year interval between soybean crops is advisable.

Yields of SCN-Resistant and Susceptible Varieties on Heavily Infested Land in Franklin County, 1968

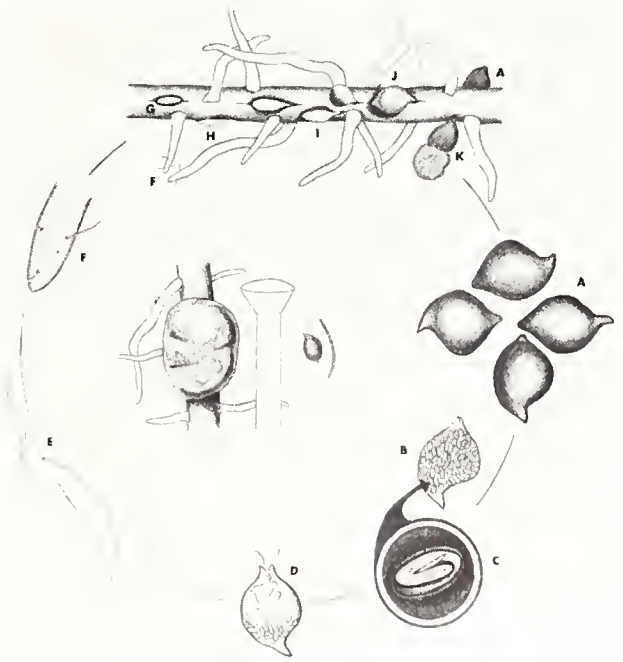
Variety	Yield, bu./A.
Custer (resistant)	38.1
Scott (susceptible)	10.4
Wayne (susceptible)	5.7
Kent (susceptible)	5.1
Clark 63 (susceptible)	8.7

Blends a possibility

As new resistant varieties are released, availability of seed will be limited until supply catches up with demand. But it is possible to stretch a limited supply of resistant beans by blending them with susceptible varieties. Blends with different ratios of susceptible and resistant seeds are now being evaluated at the Illinois Agricultural Experiment Station.

The resistant fraction of the soybean blend could act as a trap crop and dilute the SCN infestation. Infective Race 3 nematodes have been found to enter resistant and susceptible plants in equal numbers, but they generally fail to mature in resistant soybeans. The offspring from each generation would therefore be theoretically reduced in proportion to the percentage of resistant plants in the blend. As a result, there would be less subsequent infection of susceptible plants.

The use of blends could be advantageous even when seed of resistant varieties is readily available. There is evidence that Race 4 develops when SCN is continuously exposed to resistant plants. The tiny fraction of a population that is initially capable of maturing on these varieties eventually may increase to the damaging proportions observed in other states. It might therefore be advisable to avoid the planting of 100-percent resistant seed and use a blend that is adequate to produce a good yield of beans without fostering the development of Race 4.



Life cycle of the soybean cyst nematode. *A*, cysts; *B*, eggs within cyst; *C*, second-stage larva within egg; *D*, hotched larvae emerging from cyst; *E*, infective second-stoge larvae; *F*, larvoe penetrating root; *G-K*, cyst nematodes in voriaus stages of maturity. In the center are o nodule of nitrogen-fixing bacteria, the head of o common pin, o cyst, and an adult male nematode, showing the degree of magnificatian in the cycle. *Courtesy M. C. Shurtleff.*

GROWING TOMATOES IN WIRE CAGES

J. W. COURTER and J. S. VANDEMARK

FOR MANY YEARS home gardeners have used wire cages to support tomato plants. Although cages have been successful, costs have prohibited large-scale use by commercial growers.

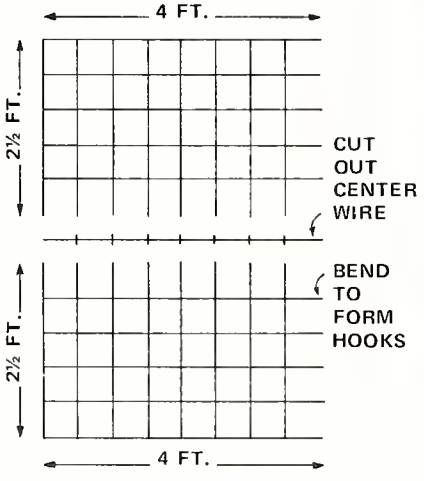
Today, however, the difficulty of getting skilled labor to train, prune, tie, and stake tomatoes — as well as increasing labor costs — may make wire cages feasible for market production. Commercial growers in Virginia, West Virginia, Massachusetts, and Michigan are testing cages on a limited scale. Cages are even being tried for greenhouse tomatoes in Texas.

Experiments at two locations

In 1972 we conducted experiments at Urbana and the Dixon Springs Agricultural Center to study the merits of cages for fresh-market tomatoes in Illinois. Better Boy Hybrid was used in the main experiments to compare responses to caging, staking, cultivated soil (ground culture), and mulching. (Black Ecolan plastic mulch was used at Dixon Springs and straw at Urbana.) In another experiment, several varieties were grown with and without cages to observe the response of varietal types.

Cages were made of 10-gauge 6 x 6-inch mesh concrete reinforcing wire. The reinforcing wire, which was 5 feet wide, was cut into 4-foot lengths. Each length in turn was cut in half to make two sections 2½ feet by 4 feet. The center wire between the two sections was cut out (Fig. 1).

Each section was bent to form a cylinder 2½ feet high and about 15 inches in diameter. The ends of the horizontal wires were bent into hooks



How wire is cut to form cages. (Fig. 1)

to fasten the cage. The ends of the vertical wires were pushed into the soil to support the cage (Fig. 2).

The cages were positioned over the plants within 2 weeks after planting, before the plants were large enough to impede placement of the cages. Thereafter plants were not trained or pruned. They were spaced 3 feet apart in rows 6 feet apart.

General observations

Cages cost about 30 cents each, not including the labor to make

Wire cages were put in place about 2 weeks after planting. (Fig. 2)

them. This represents a substantial cost, assuming 3,000 to 4,000 plants per acre. However, cages do save labor costs for staking, pruning, and training.

The cages were easily and quickly placed over the plants. None fell or blew over even after large plants grew over the top. The 6-inch prongs appeared adequate to support the 2-foot tall cage.

The cages kept most vines upright. Caged tomatoes ripened more uniformly than staked or ground tomatoes, with less green shoulder and significantly fewer sunscald defects.

Table 1. — Yield of Better Boy Tomatoes Grown in Cages Compared With Yields From Ground, Stake, and Mulch Culture

	Marketable yield, lb./plant				Aver. fruit size, oz.	
	Early*		Season			
	Urbana	Dixon Springs	Urbana	Dixon Springs	Urbana	Dixon Springs
Staked and pruned	2.6a	5.5a	10.9a	10.4a	9.2b	9.6o
Ground culture	2.7a	5.8o	25.1b	22.2b	7.4a	9.1a
Black plastic mulch	...	6.9a	...	25.0b	...	8.8a
Straw mulch	2.6a	...	28.8b	...	7.1a	...
Wire cage	1.9a	5.6a	24.2b	22.0b	8.6a	9.5a

* First two weeks of harvest.

Means in the same column followed by the same letter are not significantly different at the 5-percent level by Duncans Multiple Range Test.

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Table 2. — Cumulative Early Yields of Better Boy Tomatoes Grown by Three Methods of Culture

Harvest date	Ground culture	Caged	Staked
	lb. per plant		
July 18	0.5	0.1	0.7
July 20	1.3	0.6	1.4
July 24	2.2	1.6	2.5
July 27	2.8	2.5	3.2
July 31	5.8	5.6	5.5

Table 3. — Cumulative Early Yields of Jet Star Tomatoes Grown by Three Methods of Culture

Harvest date	Staked	Caged, unpruned	Caged, pruned
	lb. per plant		
July 13	0.6	...	0.3
July 18	1.5	0.8	1.6
July 20	2.2	1.0	2.0
July 24	5.4	2.7	3.7
July 27	7.2	3.2	4.6
July 31	8.0	7.5	6.1

Early in the harvest period, it took more time to search out and harvest the fruit in the cages than to harvest the tomatoes grown by other types of culture. However, this difference became less later in the season, when the fruits were near the top and outside of the cages.

Spraying the caged plants for pest control was not much different from spraying the staked plants.

Handling a great number of cages can be a problem. They are bulky and difficult to transport, store, and stack.

Yields

Season yields of caged plants equaled yields of mulched plants and those grown on cultivated soil (Table 1). Although cumulative yields for the first two weeks were nearly the same for cages as for the other methods of culture, the early harvest from the caged plants was delayed (Table 2). This is an important consideration for market production, since the earliest tomatoes bring the highest prices.

In a separate experiment with the Jet Star cultivar, the same delay of earliness was evident for unpruned caged plants. However, plants that were pruned when they were caged yielded early harvests comparable to those from staked and pruned plants (Table 3). By July 31, the cumulative yield from unpruned caged plants surpassed the yield from pruned caged plants.

About 10 percent fewer cull fruit were harvested from the caged plants than from the staked, soil-grown, or mulched plants at Dixon Springs. In a year of high rainfall, this difference might be much greater.

Varietal comparisons

The response of ten cultivars to caging as compared to staking and pruning or to ground culture is shown in Table 4.

The primary advantage of caging over staking, regardless of cultivar, appears to be from main season harvests. Caging doubled the seasonal yields of No. 1 and marketable fruit.

Table 4. — Varietal Response of Market Tomatoes to Cages in Comparison With Staking or Ground Culture, Dixon Springs Agricultural Center[a]

Cultivar	Type of culture	Marketable early yield, lb./plant	Total yield, lb./plant		Fruit size, oz.	Pct. cull fruit
			No. 1	Marketable		
Jet Star	Caged	7.5	18.0	23.1	7.7	13
	Staked	5.9	8.3	10.4	8.8	11
Burpee VF	Caged	7.1	17.8	25.4	8.1	10
	Staked	4.7	8.1	12.5	9.3	8
Cardinal	Caged	7.2	14.1	22.9	8.6	13
	Staked	4.6	6.8	10.0	9.2	7
Supersonic	Caged	6.6	14.8	25.0	7.5	10
	Staked	7.0	7.5	13.0	9.3	8
Traveler	Caged	3.5	19.2	22.8	5.9	7
	Staked	3.0	7.9	11.8	7.3	7
Mean, 5 indeterminate varieties	Caged	6.4	16.8	23.8	7.6	11
	Staked	5.0	7.7	11.5	8.8	8
Springset	Caged	9.0	7.6	14.1	7.2	24
	Ground	7.9	1.8	10.7	6.0	30
Spring Giant	Caged	5.9	9.8	21.2	8.3	24
	Ground	4.0	3.6	13.5	9.3	53
Campbell 1327	Caged	6.6	8.5	16.6	7.4	23
	Ground	5.8	3.3	11.3	7.4	37
Glamaur	Caged	3.5	9.2	16.5	7.5	14
	Ground	1.9	3.7	12.0	7.1	35
New Yorker	Caged	5.9	0.4	5.9	5.9	33
	Ground	3.0	0.3	3.0	4.6	61
Mean, 4 determinate varieties[b]	Caged	6.2	8.8	17.1	7.6	21
	Ground	5.0	3.1	12.0	7.5	39

[a] Plants were seeded April 10, 1972; planted May 5; and harvested from July 13 to August 18. Early yield was from July 13 to July 31.
[b] New Yorker not included.

An even greater advantage for caging was found when it was compared with ground culture for determinate cultivars. Caging significantly reduced culls and also reduced ground spotting, greatly increasing the amount of No. 1 fruits.

Not every variety is suited to cages. The early determinate variety New Yorker did not grow upright in the cages but rather tended to grow out through the sides.

Further possibilities

Home gardeners can take full advantage of cages and, for summer-long production, may utilize taller cages than those tested. Tall cages require additional material costs, a supporting stake, and more labor and storage space. Gardeners will usually find it advantageous to mulch the caged plants.

Further studies will be conducted on combining the use of cages with clear plastic mulch and pruning.

Hog Feed Discounts to Farmers

Substantially lower feed bills are possible for producers who can take full advantage of dealers' quantity discounts

JOHN T. SCOTT, JR., WILLIAM G. BURSCH, and ROY N. VAN ARSDALL

A FARMER with a large hog enterprise can save more than $4,000 a year by taking advantage of dealers' discounts for quantity purchases of feed. For smaller enterprises, potential savings are of course smaller but are still substantial.

The amount of possible savings was brought out in a survey of farmers' hog-feed buying practices and dealers' selling practices. The survey was conducted in two sections of the state: an eight-county area in western Illinois with high hog density and a ten-county area in eastern Illinois with low hog density. Altogether, 218 farmers and 101 dealers were included in the survey.

Each farmer in the survey cooperated by keeping detailed records of feed purchases. Among the items recorded were: the dealers from whom the feed was bought, type of feed, prices paid, discounts received, amount purchased at one time, credit terms, and contract arrangements. The farmers also recorded whether the feed was bagged or bulk, whether the farmer picked it up or had it delivered; whether it was ground and mixed by the farmer or by the dealer; and several other items of information.

In addition, farmers were asked about the services offered by their feed dealers: How many and what kind of services were offered? To what extent did the farmers use these services? Did the farmers' use of services clearly affect feed prices or conditions of sales?

A survey was then made of all feed dealers from whom any of the surveyed farmers had bought feed. The dealers were questioned as to their feed-selling practices and the services they offered.

The study will be fully reported in a forthcoming Agricultural Experiment Station Bulletin, "Characteristics and Prospects of the Market for Commercial Hog Feed in Illinois." This article reports just one part of the study — that having to do with dealers' discounts and the potential savings to hog farmers if they took maximum advantage of the offered discounts.

John T. Scott, Jr., is Professor of Agricultural Economics; William G. Bursch and Roy N. Van Arsdall are Economists for ERS, USDA, stationed at Purdue University and the University of Illinois, respectively. The research was supported in part by the Economic Research Service, USDA.

Types of discounts

In Table 1 we see the percentages of dealers offering various types of discounts in each area. From these figures we can make several observations:

1. In both study areas, a larger proportion of cooperatives offered quantity discounts than did dealers who were not legally organized under the cooperative acts.

2. The two main types of quantity discounts offered in both study areas were the discount for a large single purchase and the discount on total annual usage.

3. More feed dealers in both areas offered quantity discounts for a single purchase than for total annual purchases.

4. A higher proportion of both cooperatives and noncooperatives offered discounts in the western study area (high hog density) than in the eastern area (low hog density).

Table 1. — Various Quantity Discounts by Type of Dealer Ownership

	Cooperatives	Other	Total
Western study area			
No. of dealers surveyed	18	35	53
Pct. offering discounts listed			
Single purchase	67	45	52
Annual usage	39	17	25
Monthly usage	6	6	6
Other	11	17	13
No discount	11	28	23
Eastern study area			
No. of dealers surveyed	19	29	48
Pct. offering discounts listed			
Single purchase	63	55	58
Annual usage	37	7	19
Monthly usage	0	7	4
Other	5	7	6
No discount	32	38	35

Size of discounts

Table 2 gives the number of dealers who offer various discounts per ton for a single purchase, and the minimum size of purchase required for the discount. While 45 dealers did not offer any single-purchase discounts, and 23 quoted only one discount, the other 33 quoted anywhere from two to six different discounts for various sizes of purchases. Some discounts were offered for purchases of less than a ton. However, most dealers began their discount schedule with a minimum of 1 ton purchased at one time. The next most frequently mentioned minimum fell in the range of 3 to 5 tons. Only about 20 percent of the dealers specified a discount for a minimum purchase of more than 5 tons.

There is a large variation in the size of discount offered per ton, as well as in the minimum purchase required. If the discounts offered were

more consistent, the numbers in the table would mostly follow a diagonal line from the upper left to lower right, rather than being as widely scattered as they are. The variation in discounts may be due to a number of factors, including the extent and kind of other services offered by different dealers, the degree of monopoly that a dealer may have in his area, and whether or not the dealer is a cooperative.

A similar table for annual usage discounts, giving the minimum purchases required and the size of the discount per ton, would also show a wide variation.

Size of savings

Table 3 gives the potential savings from feed discounts if farmers with various volumes of hog production took advantage of the discounts offered. These discounts are for farmers who grind and mix their own feed or who feed free choice. The quantity discounts used in the table are those most frequently offered by feed dealers (the mode) at each quantity discount level.

The relationship between number of litters per year and the annual tonnage of feed purchased is based on the assumptions of 7.5 pigs or 1,650 pounds of pork per litter, and about 75 pounds of commercial feed per 100 pounds of gain.

It was further assumed that a 12-litter enterprise was too small to receive any quantity discounts. Farmers with larger enterprises would be able to take advantage of both single-purchase and annual-use discounts, with the size of the discount depending on the size of the enterprise. Annual savings ranged from $15 per farm for the smallest hog enterprise size to more than $4,400 for a farm producing 400 litters.

One of the salient points from this table is that savings per litter increase with the number of litters up to 400. Thus the savings are proportionally greater for the larger enterprises than for the smaller ones. Economists refer to such savings as the effects of externalities — effects that come from outside the firm and are due to firm size alone rather than to internal efficiencies. Beyond 400 litters we would expect no further increase in savings through regularly quoted discounts from retail feed dealers.

For hog producers who use custom feed processing, possible discounts are substantially less, ranging from $5 a year for the smallest enterprise to about $660 a year for the largest one. These producers are of course buying a package of services along with the feed. The feed price may include part of the cost of services when the price charged for services is below cost. Even so, the great difference in discounts emphasizes the importance of on-farm feed processing as an alternative that should be carefully analyzed by producers with large hog enterprises.

Table 2. — Distribution of Single-Purchase Quantity Discounts Offered by Retail Feed Dealers Surveyed, Both Study Areas

Minimum quantity required	Discount offered per ton								
	$1	$2	$3	$4	$5	$6	$7	$8	$9
	number of dealers								
Less than 500 pounds	1	1							
500–900 pounds	1	8	1	1					
1,000–1,900 pounds	1	3	2	1					
1 ton	1	17	7	14	2				
2 tons				1					
2.5 tons			1						
3 tons			3	4	1	1			
4 tons		2		5					
5 tons		3	3	4	7		1		1
6 tons		1		1		5			
7–8 tons					1	1			
9–11 tons			1			2	1		
12 tons or more				1			1	2	1

NOTE: This is a composite of the discount schedules of the dealers interviewed. Forty-five dealers did not offer a discount of this type. Twenty-three dealers quoted only one quantity discount. Others quoted as many as six different discounts associated with various quantities.

Table 3. — Budgeted Examples of Feed Discounts for Hog Operations Not Using Custom-Processing Services, Four Types of Discounts[a]

	Litters per year[b]				
	12	40	80	200	400
Tons of feed purchased per year[c]	7.5	25	50	125	250
	discount per ton, dollars				
Single-purchase discount					
$2 per ton, 1 ton minimum	...	1.00[d]	1.00[d]	.50[e]	...
$5 per ton, 5 ton minimum	...	...	2.50	3.75	5.00
Annual-use discount					
$2.50 per ton, 25 ton minimum	...	2.50	...	...	...
$3.50 per ton, 50 ton minimum	...	...	3.50	...	...
$7.00 per ton, 100 ton minimum	...	...	...	7.00	...
$9.00 per ton, 200 ton minimum	...	...	...	...	9.00
Bulk-order discount, $4.00 per ton	...	...	2.00	3.00	3.50
Pickup discount, $2.00 per ton[f]	2.00	2.00	1.00	.50	.25
Total discount per ton	2.00	5.50	10.00	14.75	17.75
Annual savings from discounts	15.00	137.50	500.00	1,843.75	4,437.50

[a] The value given for each type of discount is the one most commonly offered by dealers in the survey. The following three conditions would affect the discounts given in the table: 1. Bulk discounts are not generally offered for feed processed at the mill. 2. Few dealers offering annual-use discounts also offer custom processing (4 out of 22 in this study). 3. Buyers using custom-processing services often cannot take advantage of single-purchase discounts because relatively small, frequent purchases are required. The data in this table would apply to any livestock operation using the same feed tonnage and making purchases under the same specifications.

[b] An average of 7.5 pigs or 1,650 pounds of pork per litter is assumed.

[c] Based on the average volume of commercial feed purchased per hundredweight of pork produced, from the *1967 Summary of Illinois Farm Business Records*, Ill. Ext. Circular 987.

[d] Half of the feed assumed to be purchased under specified discount.

[e] Three-quarters of feed assumed to be bought in 5-ton lots; one-quarter in 1-ton lots.

[f] That share of the feed not delivered in bulk is assumed to be picked up at the dealer's warehouse by the purchaser.

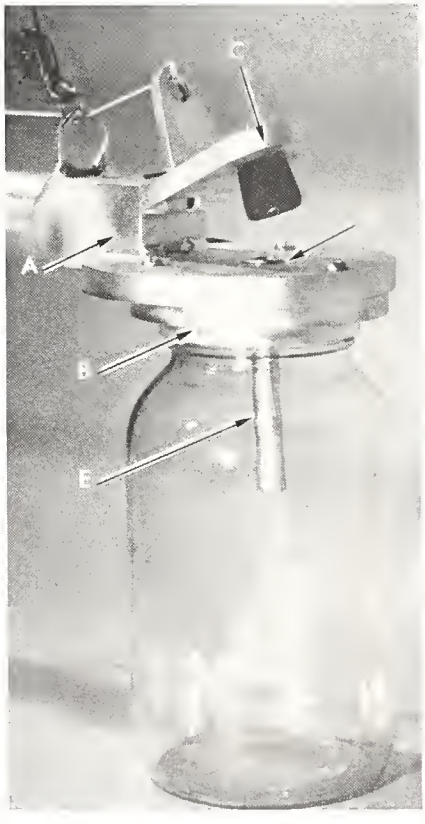
Sampling Pond Water Without a Boat

Nitrate levels in farm ponds are determined with the aid of a water sampler that can be operated from the shore

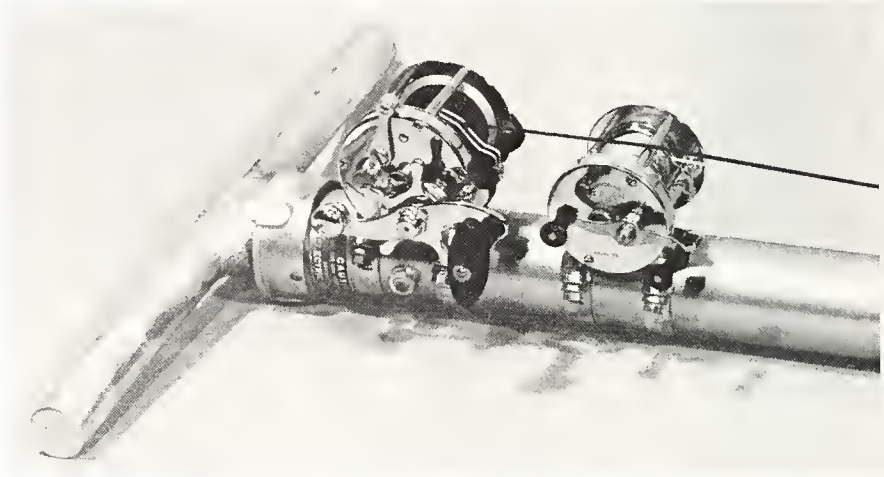
ELBERT DICKEY and J. KENT MITCHELL

THE QUALITY of pond water in southern and western Illinois is being determined with the aid of a new type of water sampler developed in the Department of Agricultural Engineering.

Work on the sampler began as part of a study of water supplies in Washington County. This study, which is being conducted through the College of Agriculture Council on Environmental Quality, was initiated in the winter of 1970, after high nitrate levels were found in the county's water supplies. Both ponds and wells are being sampled to determine their acceptability as sources of water.



Sampler head and bottle. A, base; B, bottle plate; C, stopper plate; D, water port; E, water port extension. (Fig. 1)



Operator end of sampling device. The cord from one reel is connected with the float; the other, with the sampler head. (Fig. 2)

For accurate tests of pond water, samples must be obtained at various depths and distances from the shore. A boat, however, is bulky and difficult for one person to handle. The new sampler was therefore devised so that an investigator can sample pond water at any depth without ever leaving the shore.

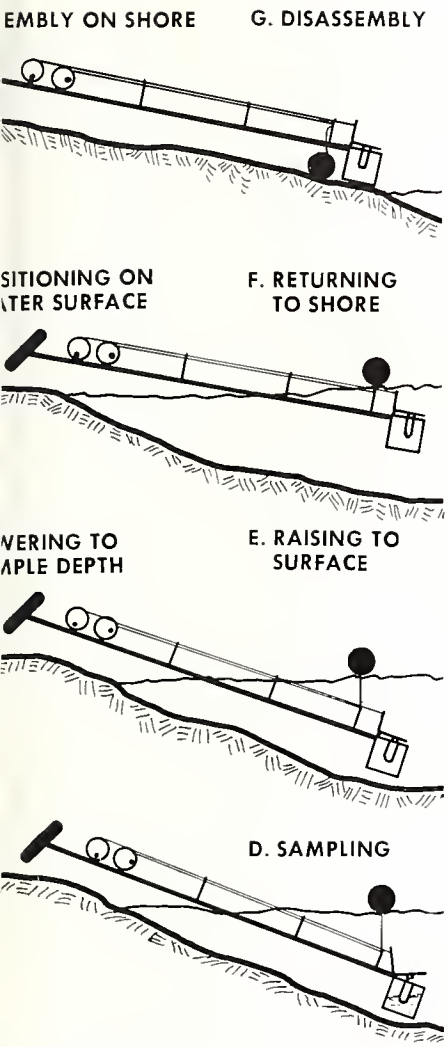
How the sampler is made

The sampler consists of a telescoping rod manufactured for window-washing units; a float, a sampler head, and a bottle at one end of the rod (Fig. 1); and a T-handle and two operating reels at the other end (Fig. 2). One reel contains the cord to the float; the other, the cord that operates the sampler head. Cord guides are attached to the rod sections.

The sampler head (Fig. 1) is made up of three components: the sampler head base, the bottle plate, and the stopper plate. The sampler head base is attached to the sampling rod and contains the water port through which water enters the sample bottle. An extension to the water port, which extends into the sample bottle, is attached to the sampler head base. In addition, the base contains an air escape port.

The bottle plate is attached to the sampler head base and is fabricated with threads for the sample bottle. The bottle plate may be easily removed from the sampler head base so that other bottle plates fitting different sample bottles may be used

Elbert Dickey is Research Assistant and J. Kent Mitchell is Assistant Professor of Agricultural Engineering.



How the sampling device is operated from the shore. (Fig. 3)

with the same sampler head. The stopper plate with stopper is spring-loaded to seal the water port while it is being positioned for sampling and after the sample has been taken.

How the sampler works

To obtain a sample, the rod is extended to the desired length and the bottle is attached to the sampler head on the pond shore (Fig. 3a). The bottle and sampler head are floated to the desired position on the pond surface with the float held tightly to the sampler end of the rod (Fig. 3b). The cord to the float is then released to allow the sampler head and bottle to sink to the desired sampling depth (Fig. 3c).

When the desired depth is reached, the sampler head cord is pulled, removing the stopper from the water port and allowing the bottle to fill with water through the water port and extension (Fig. 3d). The air is allowed to escape through the small air-escape port in the sampler head base and is conducted a few feet from the sampler head through a flexible tube. This reduces the possibility of escaping air changing the oxygen content of the water being sampled.

The sampler head and bottle are returned to the surface with the use of the float and float cord (Fig. 3e), and the apparatus is floated back to the shore (Fig. 3f). Samples have been obtained as far as 40 feet from the pond shore and as deep as 16 feet below the pond surface.

The water sampler described here and an earlier model of the sampler are being used monthly to obtain three samples from each of 15 ponds in western and southern Illinois. Both samplers have performed satisfactorily and need a minimum of maintenance.

Variable nitrate levels found

Thus far very low levels of nitrate, generally less than 3 milligrams per liter, have been found in farm ponds that have a grassed or wooded watershed. Ponds which have watersheds under a high fertility program and nearly continuous row crops have nitrate values ranging from 2 to 7 milligrams per liter.

In ponds having livestock feedlots on a major portion of the watershed, much variation in nitrate content was found. One pond, for example, has a range of 6 to 84 milligrams per liter. Also, the algae blooms in these ponds are very high at some times of the year.

It would appear that farm ponds having grassed or wooded watersheds or watersheds with a high fertility program are acceptable water supplies as far as nitrate is concerned. However, the nitrate level in ponds having a feedlot on the watershed frequently exceeds the public health limit of 45 milligrams per liter.

Notched Posts Are Likely to Decay

NOTCHING OR boring fence posts after treatment usually reduces service life, as has been shown by inspections of test posts over the past 25 years. The picture below shows how decay spread in a post after entering the notch where removal of the treated wood had exposed the untreated center of the post.

How much the service life is reduced depends on how deeply the preservative has penetrated the post. Although some woods are easier to treat than others, cold-soaking air-seasoned, peeled posts in penta solutions for 48 hours does not usually get the chemical deep enough into the wood to allow for brace notches. Pressure-treated pine posts can be notched if the notch is not too deep — perhaps no deeper than ½ inch.

The same chance for infection exists for barn poles, light standards, clothesline posts, splash boards, slotted floors, and other wood items that are notched or bored after treatment. Brush-treating the cut surface with creosote or penta is of questionable help, although it is recommended. — *C. S. Walters, Professor of Wood Technology and Utilization*

Decay in treated, notched post.

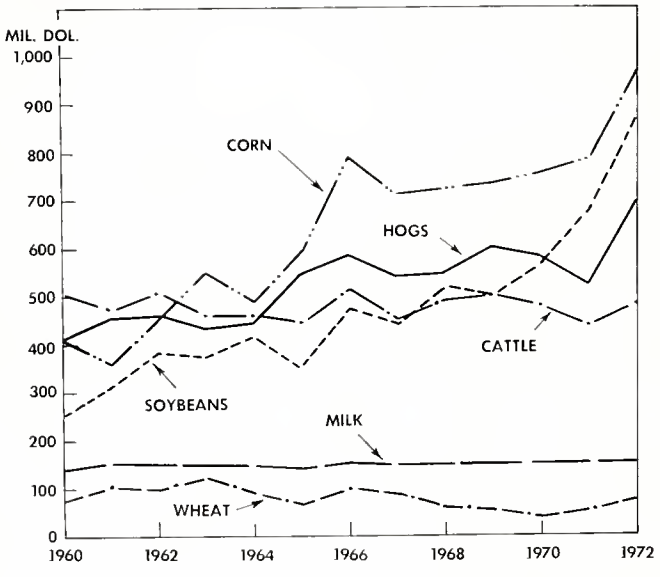
FARM BUSINESS TRENDS

IMPORTANT trends in Illinois farming are reflected in the chart below, which shows cash receipts from sales of the state's six leading farm products since 1960.

Corn and soybeans emerged as the leading cash producers, while returns from wheat diminished. Among the animal industries, receipts from sales of hogs trended upward, while sales of cattle and milk changed relatively little. The relative importance of most other agricultural products decreased.

Receipts from corn sales rose from around $400 million in the early 1960's to around $900 million in 1972. Contributing to this increase were higher acre yields, increased acreage, sales of a larger share of the crops, and higher prices. Average yields rose from around 70 bushels to 100 bushels. Harvested acreages fluctuated between 8.2 and 10.8 million acres, largely because of changes in government programs, but were usually larger in recent years than in the earlier ones. Total corn production increased from about 675 million bushels to almost 1 billion bushels. Nearly all of the increase was sold. Prices received by farmers averaged from $1 to $1.40 a bushel, with most of the higher prices coming in recent years.

Receipts from marketings of six leading Illinois farm products, 1960-1972.



Returns from soybeans climbed from $250 million in 1960 to over $800 million last year. Harvested acreage expanded from 4 million to over 7 million acres. Acre yields rose from 26 to 33 bushels and prices rose from around $2 to over $3.

Cash receipts from sales of wheat trended downward. Acreage shrank from 1.7 million to about 1 million acres. Yields increased from around 32 to 38 bushels, but prices trended downward — until after harvest last year.

Receipts from hog marketings show an upward trend since 1960 — and also reflect the four-year cycle that prevailed during this period. Returns ranged around the $450 million level during the 1960-63 cycle, and around $600 million during the latest four years. The number of hog producers decreased from about 80,000 to less than 40,000, but total hog production diminished only about 10 percent. Prices of hogs, however, went up from a range of $12-$18 a hundred pounds in 1960-63 to $15-$28 during the latest four years.

Cash returns from sales of cattle (including calves) fluctuated considerably, but showed no definite trend. Average annual prices for cattle went up from about $20 in 1960 to over $34 in 1972, but the price increase was offset by reduced volume. The number of fed cattle marketed by Illinois farmers decreased from about 1.25 million head in 1960 to about 1 million in 1972. The state's cow herd, beef and dairy, decreased from 1.3 million to 1.1 million head.

Cash receipts from milk sales held remarkably steady at around $150 million. Prices went up from about $3.75 per hundred pounds to about $5.90. The amount of milk sold, however, decreased from 4 billion pounds in 1960 to 2.7 billion pounds in 1972.

— *L. H. Simerl*

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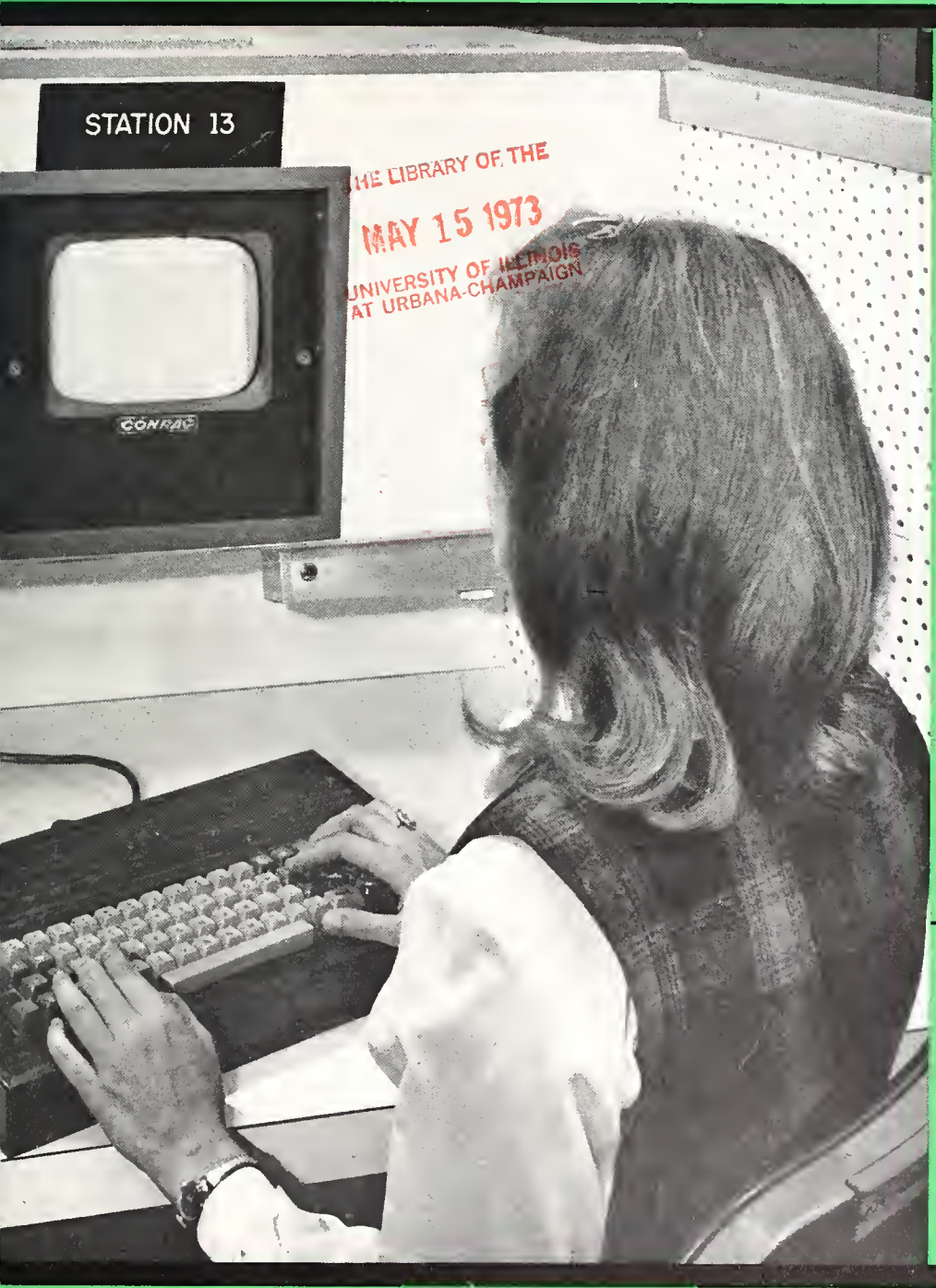

IN THIS ISSUE

Television screen and keyset at a student terminal of PLATO III. This computer-based teaching system is being utilized for two laboratory lessons on animal genetics (page 14).

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 15, Number 2

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

Spring, 1973 Volume 15, Number 2

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NEW DIRECTOR AT DIXON SPRINGS

THE DIXON SPRINGS AGRICULTURAL CENTER of the University of Illinois has a new director for its diverse research and extension activities. He is Clarence J. Kaiser, who took over his duties on January 1.

After growing up on an Indiana farm, Dr. Kaiser attended Purdue University, receiving his B.S. degree in 1952; served as a lieutenant in the U.S. Army from 1952 to 1954; and taught in high school from 1954 through 1956. Beginning in 1957, he was superintendent of the Southern Indiana Forage Farm of Purdue University for 11 years. While there, he earned his M.S. degree from Indiana University. In 1968 he went to the University of Missouri to work on his Ph.D. degree, which he received in 1970. From there he went to the University of Kentucky as Extension Specialist in Forages, a position which he held until he came to Dixon Springs.

Dr. Kaiser's predecessor at Dixon Springs was Robert J. Webb, who had been on the University staff since he received his B.S. degree in 1937 (he received the M.S. degree in 1939), and who had been superintendent of the Dixon Springs Center since 1941.

When Mr. Webb took over as superintendent, the Dixon Springs Agricultural Center (then known as the Dixon Springs Experiment Station) had been in existence only a few years. Located on 5,000 acres in Pope and Johnson Counties, it had been established in 1937 to develop sound practices of soil conservation, crop production, and animal production for southern Illinois. Under Mr. Webb's direction, research has shown that it is possible to farm profitably and still prevent erosion in this rolling area of the state.

With the continuing goal of service to southern Illinois agriculture, as well as to the state as a whole, the work at Dixon Springs has become increasingly varied. The Departments of Animal Science, Agronomy, Forestry, and Horticulture, the College of Veterinary Medicine, and the Natural History Survey are all conducting research projects there. The varied topography, soil types, and botanical and zoological phenomena at Dixon Springs invite even more diversified study in the future. — *G. W. Salisbury*

Highbush Blueberries For Commercial and Home Production in Illinois

J. W. COURTER and C. C. ZYCH

THE BLUEBERRY is truly an American delicacy. At the time of the Pilgrims, wild blueberries grew abundantly and were a prized food of the Indians. Today, the blueberry is cultivated only in the United States and Canada, although different wild species grow throughout the world, from the tropics to the northernmost limits of human habitation. Improvement of the blueberry by breeding has been an accomplishment of the last few decades.

In the United States, commercial production of the highbush blueberry is concentrated in North Carolina, New Jersey, and Michigan. The crop is also grown to a lesser extent in New England, and other species are grown commercially in Maine and Georgia.

Horticulturists have long been interested in the possibilities for blueberry production in Illinois. Experimental plantings at Urbana, Olney, Carbondale, and Dixon Springs have shown that, given proper conditions, blueberries will grow satisfactorily in this state.

This report cites current research at the Pomology Research Center, Urbana, and at the Dixon Springs Agricultural Center, Simpson.

Special soil requirements

The blueberry thrives on acid soils (pH between 4.2 and 5.2). The plant grows in the wild on sandy soils with high organic matter and a relatively high water table. However, the soil must drain freely as the plant cannot survive under waterlogged conditions.

Our research has demonstrated that blueberries will grow on the heavy clay and silt loam soils found throughout much of Illinois if the soil pH is within the desired range.

Table 1. — How Soil Treatments at Planting Time Affected Soil pH and New Growth per Plant After First Growing Season[a]

Treatment at planting time	Soil pH[b]	New growth, in.[c]
Untreated check	5.3	84.1
Soluble acid fertilizer	5.3	76.1
Peat-soil mixture	4.7	120.9
Sulfur before planting	4.4	122.5

[a] Plants mulched with corncobs.
[b] Initial pH was 5.9. Ammonium sulfate was applied to all plants on June 18.
[c] Average of 10 plants per treatment.

The pH can be lowered at planting time by using a mixture of 50 percent soil and 50 percent acid peat moss around the roots. On soils with an initial pH as high as 5.9, we have found this simple procedure as effective as applying sulfur before planting (Table 1).

A mulch consisting of a 5- to 6-inch layer of coarse organic material conserves soil moisture and provides needed organic matter as it decomposes. Sawdust, crushed corncobs, wood chips, and ground bark are suitable mulches. Irrigation during long dry periods is essential for commercial production. Fertilizing with ammonium sulfate helps to keep the soil pH within the favorable range.

Cultivars

If you carefully select two or more cultivars with different maturity dates, you can harvest fresh berries over a period of many weeks. In

Table 2. — Yields of Blueberry Cultivars, Dixon Springs, 1967-1972[a]

Variety	Season	Yield, pints per plant						
		1967	1968	1969	1970	1971[b]	1972[b]	Total
Blueray	Midseason	5.0	5.2	11.1	8.9	24.5	24.8	79.5
Herbert	Late	7.3	4.1	16.3	15.2	16.8	12.2	71.9
Jersey	Midseason	2.7	3.8	15.0	10.7	23.7	11.8	67.7
Collins	Eorly	2.5	6.6	8.7	5.3	18.4	10.2	51.7
Coville	Late	4.3	4.0	10.4	12.2	10.9	9.5	51.3
Bluecrop	Midseason	2.9	3.2	7.0	5.4	13.0	11.4	42.9
Earliblue	Early	2.8	5.6	5.0	3.2	13.4	10.6	40.6

[a] Planted April 26, 1965; spacing 12 x 6 feet; sawdust mulch; irrigation as needed. There was no bird control and losses were severe in 1972.
[b] Pick-your-own method of harvesting.

J. W. Courter is Associate Professor of Horticulture, Dixon Springs; C. C. Zych is Professor of Pomology, Urbana.

Since birds love blueberries, the berries should be protected with netting or in some other way — cheesecloth, for example, may be spread over a single bush. (Fig. 1)

This experimental planting near Robinson has done exceptionally well and is marketed as pick-your-own. (Fig. 2)

Table 3. — Yields of Blueberry Cultivars, Urbana, 1970-1972[a]

Cultivar and seoson[b]	Yield, pt. per plant			
	1970	1971	1972	Total
Coville (L)	7.2	11.2	9.1	27.5
Berkeley (M)	3.4	8.3	9.7	21.4
Lateblue (VL)	4.0	7.2	8.9	20.1
Pemberton (M)	3.8	7.9	8.3	20.0
Atlantic (M)	4.4	6.4	8.7	19.5
Burlington (L)	5.3	6.1	7.0	18.4
Dixi (L)	3.1	6.9	7.7	17.7
Darrow (L)	4.2	7.7	5.4	17.3
Blueroy (M)	3.8	5.9	7.4	17.1
Bluecrop (M)	3.3	6.6	6.5	16.4
Jersey (M)	2.6	6.5	6.9	16.0
Herbert (L)	3.3	5.6	6.6	15.5
Weymouth (E)	3.1	3.4	8.4	14.9
Collins (E)	2.8	4.6	7.0	14.4
Stanley (M)	2.4	5.3	5.8	13.5
Ivanhoe (M)	1.9	3.5	6.0	11.4
Earliblue (E)	1.8	2.1	3.9	7.8

[a] Planted April 10, 1968; spacing 9 x 6 feet; crushed corncob mulch; netting for bird control; irrigation as needed.
[b] E = eorly; M = midseoson; L = late; VL = very late.

Urbana, the earliest cultivars are ready to harvest about June 20, while the latest cultivars will bear until early August. Selection of more than one cultivar also insures adequate pollination for maximum fruit set and production.

A number of cultivars can be recommended. In making recommendations, we considered season of maturity, yield performance, winter hardiness, fruit size and quality, and adaptability to Illinois.

The best suited cultivars are Collins, Blueray, Jersey, Berkeley, and Coville (Tables 2 and 3). Bluecrop can be grown in northern Illinois, but is less reliable in the south.

Pemberton, Dixi, and Herbert are good cultivars, but should be limited to home gardens or pick-your-own because of poor scars, cracking, or fruit softness, all of which detract from shipping and keeping quality. Darrow and Lateblue appear promising (Table 3), but we haven't looked at them long enough to recommend them. Lateblue is the latest of all these types and could extend the picking season by about a week.

The recommended cultivars should yield 10 or more pints a plant after they reach maturity in 6 years (Table 2). However, birds dearly love blueberries and you will need to cover the plants with protective netting if you want to realize full crops (Fig. 1).

Commercial potential

While blueberries are relatively unknown outside of supermarkets in Illinois, they do offer exciting possibilities for commercial production. Their greatest potential is probably for pick-your-own and local marketing (Fig. 2). They are easy to pick and stay on the bush for several days after they turn blue. Once people learn to enjoy the fresh fruit, they can't seem to get enough. Blueberries make tasty syrups, and are delicious in muffins, pancakes, and pie. They are also easy to freeze.

In a small experimental planting at Dixon Springs, berries sold by pick-your-own are so popular that reservations to piek must be made 1 to 2 weeks in advance.

At least two large commercial plantings are now established in Illinois, and several others have been made recently or are being planned. We expect this trend to continue.

Attractive in home landscape

By growing a few blueberry bushes, the home gardener can have not only fresh berries but an attractive landscape planting as a bonus. Blueberry plants grow in an upright manner and are easy to keep in bounds. The leaves, which are little troubled by disease, are an attractive green in summer and brilliant red in fall. And in winter, the twigs are a colorful contrast against the snow.

For further information on growing blueberries at home, obtain Illinois Extension Circular 935, "Growing Small Fruits in the Home Garden." It is available from your County Extension Office or the Office of Agricultural Publications, 123 Mumford Hall, Urbana, Illinois 61801.

Organic Gardening Can Be Successful If You Follow Sound Principles

J. S. VANDEMARK, W. E. SPLITTSTOESSER, and ROSCOE RANDELL

MANY HOME GARDENERS are taking up organic gardening, or gardening without chemicals for weed and pest control. But this does not mean gardening with neglect. For successful organic gardening, you need to control weeds, insects, and diseases; and you need to follow other established gardening practices.

Providing nutrients

First of all, the soil must have adequate nutrients. To supply some of these nutrients, you can work undecomposed organic material (such as leaves, grass clippings, peat moss, straw, or hay) into the soil. Bacteria and tiny fungi will break down this material into nutrients that plants can use. But these bacteria and fungi are heavy users of nutrients themselves, so your garden will need another natural source of nutrients, such as compost, manure, sewage sludge, steamed bonemeal, rock phosphate, muriate of potash, or hard wood ashes. Since organic matter will tend to make the soil slightly acid, a little ground-up agricultural limestone or marl may be needed.

Planting and general care

Be sure to plant at the proper time. Plant in rows, leaving adequate space between plants. If you start with seed, thin the plants to the proper spacing after they have emerged. Use fresh commercial seed that is free of disease.

As soon as the seedlings can be identified, remove the weeds and grass by very shallow hoeing. Weeds not only compete with your garden plants for fertility, water, sunlight, and space, but may also harbor insects and diseases.

The space between the vegetable rows can be filled in with a mulch of undecomposed organic matter such as straw, leaves, grass clippings, or sawdust. The mulch will help control weeds and save water, and will eventually decay into humus.

Mulches, stakes, cages, or other training methods on plants should be used wherever feasible, especially for tomatoes. If tomato fruit comes in contact with the soil it is susceptible to various fruit rots.

To avoid soil compaction, do not work the soil when it is wet and sticky. Do not walk through the garden when it is damp as this will spread plant disease. Avoid watering plants in the evening. If the soil surface stays damp all night, disease organisms can thrive.

Insect control

Some crops can be grown with little or no danger from disease or insect pests. These include radishes, lettuce, onions, leeks, shallots, chives, beets, chard, mustard, Chinese cabbage, parsnips, salsify, peas, spinach, sweet potatoes, turnips, and most herbs. Tomatoes can be grown if you hand-pick the tomato hornworms.

By paying attention to timing, you can also grow sweet corn without chemicals. If you plant corn about the middle of May, it will usually silk after June 15 and before mid-July, when there is little risk of serious earworm infestation.

Biological control is effective against some insects. This is the use of living organisms to reduce the number of damaging insects below a level of economic importance.

Bacillus thuringiensis, a microbial preparation, is available in several commercial formulations. It controls cabbageworms, tomato hornworms and fruitworms, webworms, and bagworms. With this type of biological control, you can successfully grow green beans, cabbage, kale, collards, brussels sprouts, broccoli, and cauliflower.

Tomatoes staked and mulched to help prevent fruit rot and preserve soil moisture.

Lady beetles are sometimes released in gardens as a means of biological control. Although their preferred food is aphids, they will also eat eggs of several other insects. However, they do not kill grubs, Japanese beetles, or caterpillars. And if there is not an ample supply of live aphids on the plants when the beetles are released, they will eat each other or leave the area.

Praying mantid egg masses are also sometimes used. But mantids are poor searchers for food, usually waiting for their prey to come to them. They prefer grasshoppers, crickets, bees, wasps, and flies, and so may destroy beneficial insects.

Some crops are difficult to grow organically. Striped cucumber bugs spread bacterial wilt among cucumber, muskmelon, pumpkin, and summer squash plants. And flea beetles devour eggplant with gusto.

Despite organic precautions against insects, pest epidemics may become a threat. An insecticide is then needed to reduce the pest population to a tolerable level. Insecticides of vegetable origin such as pyrethrins, rotenone, and nicotine, may be used. Also, many man-made insecticides are both safer and more effective than botanical insecticides.

For more information, consult your County Extension Adviser, or the Extension Specialist in Vegetable Crops, University of Illinois, Urbana.

J. S. Vandemark is Professor of Horticulture; W. E. Splittstoesser, Associate Professor of Plant Physiology; Roscoe Randell, Assistant Professor of Agricultural Entomology.

CANNED PORK AND SOYBEANS: A Nutritious and Tasty New Product

L. S. WEI, RUBEN BERRA, A. I. NELSON, and M. P. STEINBERG

Soybeans are one of the most nutritive vegetable foods known to man. They contain about 40 percent protein and 20 percent oil on a dry basis, as compared with only 26 percent protein and 2 percent oil in, for example, navy beans. What's more, soybean protein is more nutritious than navy bean protein, and soybeans normally cost only about a third as much as navy beans.

So far, the soybean has not been widely used for human food because of a highly undesirable odor and flavor characterized as "beany" or "painty." However, work in the Department of Food Science has shown that this odor and flavor are not inherent in the bean, but are induced by enzymes when ruptured cells are moistened. Simple processing of the whole bean was found to inactivate enzymes and prevent undesirable flavor and odor. On the basis of this discovery, soybeans have been used to develop a number of fresh cooked, canned, dried, and frozen prototype food products — all of which are highly desirable and nutritious with no unpleasant odors or flavors.

One of the soybean food products developed in the Department of Food Science is canned pork and beans, with soybeans substituted for navy or pea beans.

Soaking and blanching beans

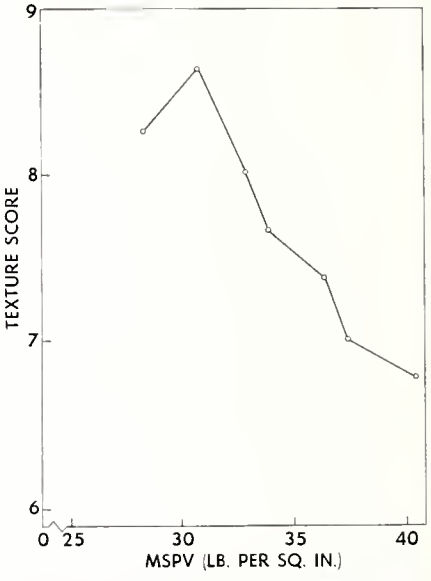
When dry navy beans are prepared for the usual pork and beans product, they are ordinarily soaked in water for up to 15 hours. However, it was believed that soaking soybeans in water might lead to off-flavor caused by enzyme action, and that soaking in an acid solution might decrease such action.

To test this hypothesis, soybeans were soaked in water and in 3, 5, and 7 milliliters of phosphoric acid per liter. Beans were weighed just before soaking, and after 5, 8, and 28 hours of soaking. During the first 5 hours hydration increased rapidly to over 100 percent in all solutions. Hydration was greatest in the water, reaching 140 percent after 28 hours as compared with 130 percent in the acid solution.

It had already been determined that the whole soybean can be made enzyme-inactive by blanching in boiling water. Might it therefore be possible to achieve hydration and enzyme inactivation at the same time? To answer this question, dry beans were placed directly into boiling water and boiling solutions of 3, 5, and 7 milliliters of phosphoric acid per liter. Degree of hydration was measured after 15, 20, and 25 minutes.

Hydration occurred much faster in water than in acid. In water, hydration was 104 percent within 20 minutes, while in acid it was still 92 percent after 25 minutes. Water-blanched beans had a pH of 6.8; acid-blanched beans had a pH close to 5.3. Reducing pH of the tissue toward the isoelectric point evidently hindered hydration. It may be noted that 25 minutes in boiling tap water gave as much rehydration as soaking for 5 hours at 60° F.

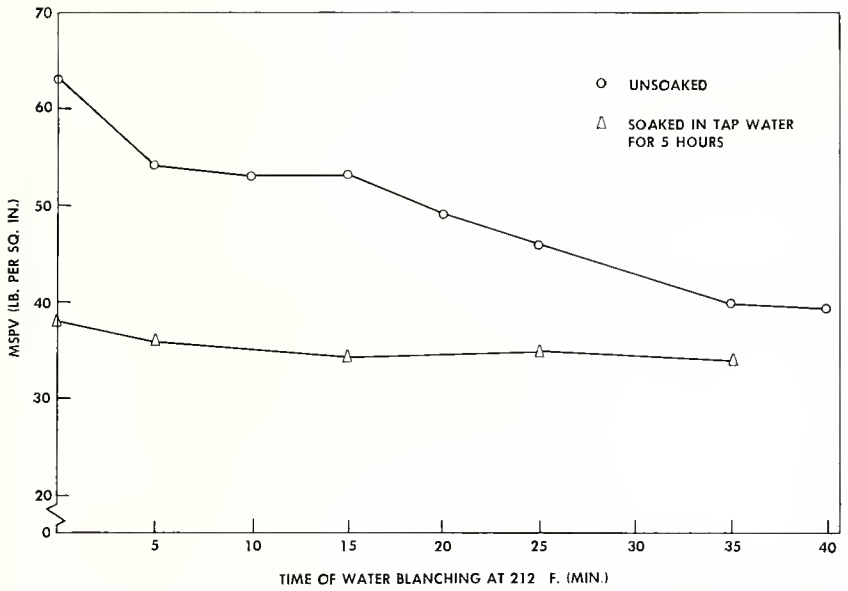
Dry beans blanched in boiling water and in a boiling solution of 5 milliliters of phosphoric acid per liter were subjected to the urease test to show degree of enzyme inactivation. Enzymes were inactivated after 10 minutes in acid and 15 minutes in water. Since more blanch time was required for hydration than for enzyme inactivation in both water and acid, and since hydration was faster in water, there was no advantage to using an acid blanch.



Relationship between maximum shear press values (MSPV) and organoleptic texture scores (9 is excellent; 6, borderline). Average of 3 replications. (Fig. 1)

It has been reported that navy beans blanched in hard water are less tender than those blanched in soft water. Sodium bicarbonate was therefore added to the blanch water and its effect on soybean tenderness before and after thermal processing was studied. Regardless of soaking, soybeans blanched in the bicarbonate solution had shear press readings that were about 60 percent of the readings for water-blanched beans. However, beans that were soaked before blanching were always much softer than unsoaked beans. It was therefore concluded that both soaking and addition of sodium bicarbonate to the blanch water helped to tenderize the beans.

L. S. Wei is Associate Professor of Food Science; Ruben Berro, former Research Assistant; A. I. Nelson, Professor of Food Processing; M. P. Steinberg, Professor of Food Engineering.



Change in maximum shear press values of canned soybeans made with soaked and unsoaked beans blanched for various times. (Fig. 2)

Organoleptic Flavor and Texture Scores and Maximum Shear Press Values, Commercial Pork and Beans and Park and Saybeans[a]

Sample	Organoleptic score[b]		MSPV, lb./in.[2]
	Flavor	Texture	
Commercial 1	7.6	7.5	11
Commercial 2	7.7	7.7	36
Commercial 3	7.6	7.2	32
Commercial 4	6.9	7.4	8
Commercial 5	6.7	7.4	8
Soybean	7.0	7.7	28

[a] Average of two replicates.
[b] Rated on a 9-point hedonic scale, with 9 as excellent and 5 as just acceptable. (Average of ratings given by 10 taste panel members.)

Preparing the canned product

The sauce for commercially canned pork and beans is made mainly from tomato pulp, sugar, salt, onion, and flavorings. Various combinations of these ingredients were used in preparing 14 different sauces for canned pork and soybeans. The sauces were added to soybeans that had been soaked for 5 hours in water and then blanched for 20 minutes in a 0.5-percent sodium bicarbonate solution. A 2-inch strip of bacon was added to each can.

After the beans were cooked, they were evaluated organoleptically by our taste panel for flavor, aroma, and appearance. The sauce formula that was rated the highest was as follows: tomato pulp (10 percent S.S.), 400 milliliters; onion powder, 15 grams; garlic powder, 1 gram; brown sugar, 100 grams; molasses, 50 grams; salt, 50 grams; corn starch, 40 grams; cayenne pepper, 0.76 gram; charzyme, 1 gram; trace of oil of cloves and oil of allspice; water to make up 0.5 gallon.

Testing the product

It was important to determine the range of shear press readings that would give acceptable organoleptic texture of the final canned beans. Maximum shear press values (MSPV) in the range of 28 to 33 psi were found to correspond with organoleptic ratings of highly acceptable (Fig. 1). Beans with MSPV between 33 and 40 psi were still acceptable, but had substantially lower organoleptic texture scores than beans with lower MSPV.

Having established the range of acceptable MSPV, we next studied the soaking process to determine whether it could be eliminated by increasing the blanching time. Canned products were made from soaked and unsoaked beans blanched for varying periods.

Regardless of blanching time, the canned product made with unsoaked beans was less tender than that made with soaked, blanched beans (Fig. 2). Length of blanching had little effect on the texture of the soaked beans. However, as blanching time was increased from 5 to 40 minutes, the MSPV of the unsoaked beans changed from an unacceptable reading of 60 psi to a barely acceptable reading of 40 psi.

Another test was aimed at discovering whether bicarbonate in the blanch solution would tenderize the beans enough to make presoaking unnecessary. Canned products made with soaked and unsoaked beans blanched in tap water or in 0.5-percent sodium bicarbonate were organoleptically evaluated for flavor, appearance, and texture by the triangle test.

With both blanching solutions, the soaked and unsoaked beans were rated quite differently. The panel preferred the texture and flavor of the soaked sample, but they preferred the appearance of the unsoaked sample — mainly because of its dark brown color. However, it is believed that the appearance of the soaked sample can be improved by adjusting the sauce formula.

These two tests confirmed our earlier judgment that the beans should be soaked before blanching even if a bicarbonate blanch is to be used.

A highly acceptable food

The pork and soybean product was evaluated in comparison with several commercial pork and bean samples. The soybeans were considered as acceptable as the commercial products — and in some instances were even judged to be superior (see table). Thus food processors could use soybeans to increase the nutritive value and reduce the cost of a popular food item.

To make a similarly tasty and nutritive product at home, you can substitute soybeans for navy beans in your favorite baked bean recipe. The soybeans should be soaked in water for several hours, then blanched in a solution containing 1 teaspoon of sodium bicarbonate (baking soda) to a quart of water.

Will Conservation Tillage Increase The Incidence of Plant Disease?

EDWARD E. BURNS

Dust bowls, "tired soil," and huge gullies resulting from erosion due to farm practices are, it is hoped, a thing of the past. Wind and water erosion have been greatly reduced by such conservation tillage practices as terracing, strip-cropping, grass waterways, stubble-mulch farming, minimum tillage, and selective land use. Since farmland will provide most of our food in the foreseeable future, practices to protect our soil against the forces of nature will need to be ever more rigorous.

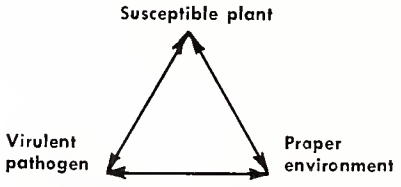
However, the question arises as to whether minimum tillage will increase the incidence of plant disease, since various disease organisms can survive in crop debris left on the soil surface and in volunteer plants and weeds.

Plant disease is a serious problem, destroying an estimated 10 percent of U.S. crop production every year. Over 80,000 different diseases have been described in the literature. Fortunately, however, not all diseases can occur at any one place or time, and not all crop varieties are susceptible to every known pathogen.

Conditions necessary for disease

For disease to occur, there has to be just the right combination of three factors: a susceptible host, a virulent pathogen or causal agent, and a suitable environment. If any one factor is missing, the disease will not develop.

Thus, the debris and volunteer plants resulting from minimum tillage will increase plant disease only when the following conditions hold true: (1) A pathogen exists in the crop area. (2) The pathogen has the ability to survive from one growing season to the next. (3) A susceptible variety is planted. (4) Environmental conditions favor the establishment and development of disease.



The interaction of three factors is necessary for disease development.

Each specific disease has its own unique characteristics and environmental requirements. And disease organisms have developed various mechanisms for survival. For example, root fungi and some pathogens infecting aerial plant parts may survive by (1) becoming competitive saprophytes, which live on dead organic matter; (2) forming dormant "resting" or overwintering propagules such as oospores, chlamydospores, sporangia, or sclerotia; (3) parasitic survival on weeds or volunteer plants; or (4) parasitic survival on latent hosts.

A few common plant diseases are discussed in the following paragraphs. Emphasis is placed on recent University of Illinois studies concerning the effect of minimum tillage on southern corn leaf blight (SCLB).

Southern corn leaf blight

The SCLB studies were conducted on experimental fields at Dixon Springs, Elwood, and Urbana. The fields had been infected with blight in 1970. In the fall of 1970, five different tillage treatments were tried. These included zero-till and various combinations of moldboard plowing, shredding, disking, and chiseling.

Once a month, from November, 1970, to April, 1971, a handful of infected corn debris from each plot was tested in the laboratory to see if it contained living *Helminthosporium maydis*, race T (the blight-causing organism). The test was made by preparing inoculum from the debris and using it to treat seedling male sterile T- and N-cytoplasm corn.

Every month of the tests, viable conidia were obtained from corn debris left on the soil surface. Thus, such tillage practices as chiseling and zero-till, which left debris on the surface, favored the survival of race T.

These results were confirmed by a second experiment with seedling corn leaves that had been infected with the race T or race O and put into nylon-mesh bags. Some bags were buried at two different depths in the soil to simulate the placement of debris after various tillage methods. Other bags were staked 1 foot above the ground surface to simulate zero tillage. Once a month, from December, 1970, to July, 1971, bags from each series were collected and the leaf sections were examined for living *H. maydis*. Seedling corn differentials (T and N) were also inoculated with this material.

Viable spores of race T were found every month in bags that had been staked above the ground. However, race T did not survive burial in the soil beyond March. Spores or hyphae of race O did not survive either above or below the soil surface after a month's exposure to weather conditions at Urbana.

With the knowledge that race T was surviving in the debris above the soil surface, we planted susceptible T-cytoplasm corn in the spring of 1971. Blight appeared first on corn

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in the zero-tillage plots, but since the spores of *H. maydis* are air-borne, the blight eventually spread to all plots.

The tillage experiment was repeated in 1971-72. Results were similar to those in 1970-71.

Although *H. maydis* survived the 1970-71 winter, southern corn leaf blight was not generally serious in 1971 for at least three reasons: (1) Over 50 percent of the corn grown was resistant normal (N) cytoplasm. (2) At various times the weather was either too hot, too cool, or too dry for infection and reproduction of the fungus. (3) Corn was planted early and matured before the danger period for blight.

If farmers had not been able to get any resistant N corn, and if warm, humid weather had occurred, tillage practices would have significantly affected blight development. In 1972 wet weather did occur and blight might have been a serious problem, but by this time everyone was growing N corn or highly tolerant T corn in blends with N corn.

Other diseases

Brown spot. An experiment with brown spot of corn was conducted in cooperation with Dr. James Reynolds of Holden Foundation Seeds. This disease is caused by *Physoderma maydis,* which overwinters as sporangia in infected corn tissue on the soil surface.

In 1972 susceptible hybrids were planted on plots that had been infected with brown spot in 1971 and had received different tillage treatments after the 1971 harvest. Brown spot disease was most severe on the reduced-tillage plots. Almost no brown spot developed on plots that had been plowed. Dry weather in the spring of 1972 prevented severe damage by delaying the release of zoospores from sporangia blown or splashed into the whorls of plants.

Fusarium stalk rot. Fragments of infected cornstalks are an important source of the stalk-rotting fungus *Fusarium moniliforme.* Research data from the University of Minnesota indicate how the number of surviving fungus propagules can be greatly reduced: Infected stalk fragments can be shredded to reduce their size, or they can be exposed to conditions favoring disintegration of the tissue.

In the absence of host tissue, *F. moniliforme* does not exist very well in the soil. Use of resistant corn would be advisable for continuous corn in a minimum tillage system where Fusarium stalk rot is a problem.

Soybean cyst nematode. The soybean cyst nematode (*Heterodera glycines*) persists in soil as cysts (dead female bodies), each containing 200 to 600 eggs. Custer is the one commonly grown resistant variety adapted to southern Illinois, the only part of the state where the nematode has thus far been economically damaging.

Cysts remain viable for many years, but 3- to 5-year rotations with nonsusceptible crops such as corn will reduce nematode populations enough to permit near-normal soybean yields in infested fields. Some pasture crops (such as sweet clover, crownvetch, birdsfoot trefoil, and lespedezas) are also hosts of *H. glycines.*

Charcoal rot is caused by the fungus *Macrophomina phaseoli,* which survives in soil and soybean stubble as minute black sclerotia. It attacks corn, soybeans, wheat, and sorghum. Since these crops could be grown in rotation, a constant check should be made in fields where the pathogen has been found. Fortunately, dry weather at harvest time is needed for extensive development of the disease, and this is one reason why charcoal rot is still a relatively minor problem in Illinois.

Two wheat diseases. Double-cropping soybeans in wheat stubble may cause a significant increase in Septoria leaf blotch of wheat and wheat streak mosaic virus. *Septoria tritici* overwinters either as mycelium in living wheat plants or as pycnidia in dead plant refuse. The fungus oversummers in infected plant debris and volunteer wheat, then infects winter wheat seedlings as they emerge in the fall.

Wheat streak mosaic virus and the mites that transmit it overwinter on living wheat and perennial grasses. This virus does the greatest damage to winter wheat in fields next to volunteer wheat or wheat stubble that was not plowed down before sowing.

Changing control measures

At present, no serious plant disease problems appear to be associated with conservation tillage. However, some of our common disease-control measures may change as we learn more about the effects of conservation tillage on the prevalence and severity of plant diseases.

The concept of a "pathogen-free" soil or area may have to be modified to mean that the soil or area has been treated to reduce the pathogenic inoculum content to an economically acceptable level rather than to zero. Adjustments can be made in the future as more disease situations are examined.

Crop sanitation involves eradication of the pathogen by removing or destroying infected crop debris in the field after harvest. However, debris cannot be plowed down when a double-cropping system is used or when erosion must be controlled. In the future it may become unlawful to plow down certain areas and to burn crop refuse. The effectiveness of these practices in disease control is questionable anyway.

Crop rotations work if they deprive a pathogen of suitable hosts. Their efficiency declines if the pathogen can survive as a saprophyte or in some other way.

Many other measures for controlling plant diseases are available. These include: (1) exclusion of a pathogen by quarantine; (2) avoidance of situations conducive to disease build-up and spread; (3) incorporation of genetic or cytoplasmic resistance factors into hosts; and (4) chemical protection of susceptible host plant parts. The measures chosen will depend upon the balanced input of all known factors — taking into account the need for erosion control and soil conservation as well as for disease control.

Prevent Warping and Cracking of Wood

Wood objects bought in foreign lands or made at home will remain in good condition with proper seasoning

C. S. WALTERS

EACH YEAR visitors to foreign lands return home with carvings, furniture, wall plaques, and other wood products that too often crack or warp after a short period in our warm, dry Illinois homes (Figs. 1 and 2). The stay-at-homes may have been making their own wood furniture and carvings, but they too may encounter the same problems of warping and cracking.

In both cases the basic difficulty is the same: changes in moisture content that cause the wood to shrink or swell. The wood used by the do-it-yourselfer may not have been seasoned enough. The article made abroad may have been seasoned for the temperature and relative humidity where it was made, but not for the environment where it is being used.

Wood needs seasoning

When a tree is cut into lumber, the green wood still contains the sap that is so necessary to the life and growth of the tree. Sap is mostly water. To make the wood usable for flooring, doors, windows, furniture, and other products, it must be dried.

When wood dries to about 30 percent moisture content, it is said to be at fiber saturation point (FSP). If the wood dries below the FSP, it shrinks (Fig. 3). When the tensile forces that accompany shrinkage reach a certain level, the wood warps or it is pulled apart along the grain with cracking or checking as the result. Checks will be small at first, but they become larger if there is enough shrinkage. Without shrinkage, warping and checking never develop.

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The lid of a teak box that was made in Java and brought back to Illinois. The top part of the lid has shrunk away from the lower part. Shrinkage has also caused cracking around the nails in the lower part of the lid. The long horizontal crack is due as much to shipping damage as to shrinkage. (Fig. 1)

As dry wood gains moisture, it will swell until it reaches FSP, at which point it attains its maximum dimensions, and will no longer swell no matter how much more water it gains.

When wood is used in a home, a little shrinking and swelling can be tolerated, but neither should be enough to cause wall paneling and flooring to buckle or a carving to crack. Changes in the dimensions of a wood product can be minimized by gradually drying it until it is as close as possible to the equilibrium moisture content (EMC) it will have when kept in a room with a specific temperature and relative humidity. Regardless of whether a piece of wood is dry or green when put into a specific environment, it will eventually reach EMC.

Wood Equilibrium Moisture Content (EMC) for Various Temperatures and Humidities

Temperature of air, °F.	Relative humidity, pct.	EMC, pct.
70	15	3.7
70	30	6.2
70	60	11.0
70	90	20.6
80	15	3.5
80	30	6.0
80	60	10.7
80	90	20.4
90	15	3.3
90	30	5.9
90	60	10.4
90	90	19.7

The table at left gives EMC's for different temperatures and relative humidities. In most Illinois homes, the EMC ranges between 8 and 10 percent.

Methods of seasoning

To season wood, enough heat (energy) must be provided to vaporize the sap. Commercial manufacturers use steam-heated dry kilns. A dry kiln is a box or chamber in which the air temperature and the relative humidity can be regulated. With the controlled environment, lumber from each species can be dried at the optimum rate — slowly enough to prevent warping and cracking, but fast

enough to get rid of the sap in a hurry.

Kilns are expensive, however, and not readily available in Illinois; so the seasoning process becomes a cut-and-try method for the homeowner. Following are some suggestions for conditioning wood at home — whether it is a carving or other object bought abroad, or whether it is lumber that you want to work with yourself.

Moisture must be evaporated slowly. When green wood starts to dry, the fibers on the surface quickly reach EMC. The interior of the wood, however, is still at a relatively high moisture content. This moisture will then diffuse to the drier areas. As moisture reaches the surface it will evaporate, leaving room for more moisture to come to the surface and be evaporated in turn. The process of moving water from the interior of the wood to the surface must proceed gradually and uniformly to avoid warping and checking.

The rate of drying depends on the temperature and relative humidity of the air, and on the velocity of the air circulating about the wood. The warmer and drier the air, the faster will be the loss of water. Moving air evaporates moisture from wood quicker than stagnant air.

Moisture moves from the interior of the wood to the surface 15 to 20 times faster along the grain than it does across the grain. This is why the ends of boards often crack before the edges or faces.

To compensate for differences in drying rates, the loss of moisture must be controlled. Coat the foreign-made carving or other product with neutral shoe-polish wax as soon as possible after you buy it. Be sure to coat all crevices and the base surface. Storing the carving in a plastic bag will also help.

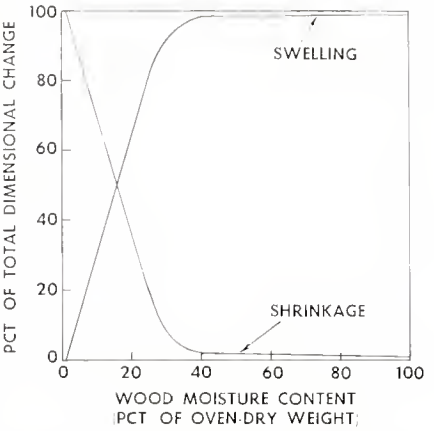
The do-it-yourselfer can coat bowl blanks, ends of boards, and similar surfaces with paste wax or neutral shoe polish. Paint or paraffin can also be used on the end grain.

Wax emulsions that contain water are not as good for coating as paraffin or paste wax. Linseed oil is often used, but it evaporates and needs to be replaced periodically.

Once the end-grain surfaces are coated, change storage conditions by moving the wood from damp areas to successively drier areas. Lumber, for example, may be stored for a while in the garage or barn. It can then be moved to a cool room in the basement, to the furnace room, and finally to the work room. A foreign-made wood object may be similarly moved from a humid storage area to a less humid one before it is put on display.

Conditions in the work shop should be about the same as they will be in the area where the finished product will be used; otherwise, the wood will change dimensions after it is in manufactured form. If checks appear while the article is being made, they are an indication that the wood has not reached EMC. A coating of shellac or spray lacquer will slow moisture loss during shop operations, but this is a stop-gap measure and is no substitute for proper conditioning of the raw wood. Before paneling or flooring is nailed in place, it should be stored for two or three days in the room where it will be installed. This allows the wood fibers to adjust in moisture content so that shrinking and swelling will be minimized later.

Like the box in Figure 1, this teak jar came from Java. The lid has shrunk so that it no longer fits. (Fig. 2)



Effect of moisture content on shrinkage and swelling of wood. Moisture content is expressed as a percentage of the weight of wood that has been dried at 215° F. Thus, a green board that weighs 13 pounds and contains 3 pounds of water has 30 percent moisture content. (Fig. 3)

Wood continues to adsorb water

Although it was suggested above that wax or paint coatings help to control moisture loss during the seasoning process, you cannot keep water out of wood over a long period by finishing it. Wood (cellulose) molecules have a terrific affinity for water molecules. Many finished products are not completely coated, so some areas of the wood always remain exposed to the water vapor in the air. As the vapor enters dry wood, it is compressed to liquid and swelling occurs. Many times the swelling stretches the finish until it cracks; water vapor then enters the wood through the tiny cracks.

Finishes can slow down wood's adsorption of water, but they cannot stop it entirely. Thus the total amount of shrinking and swelling that occurs with change in moisture content of finished wood ultimately is the same as for unfinished wood, although the daily change is reduced considerably.

Correcting wood's bad habits of shrinking and swelling will increase your enjoyment of its beauty and other desirable qualities.

CHILDREN AND MONEY . . .

KAREN SCHNITTGRUND,
MARILYN DUNSING,
and JEANNE HAFSTROM

Attitudes and Behavior of 52 Grandparent and Parent Families

How do parents feel about allowances for their children? Payment for household jobs? Financial plans for the children's higher education? Children's participation in family financial discussions and decisions? Are the parents' attitudes about such matters similar to those of their own parents?

A recent pilot study has provided some answers to these questions. Objectives of the study were: (1) to determine if parents' money management practices with their children tend to be like the practices of their parents with them when they were children; (2) to report similarities and differences between parents' and grandparents' attitudes about money; and (3) to find out whether one parent tends to have more influence than the other on the money management practices they follow with their children.

The study differed from earlier studies in this area in that information was sought about actual money practices using a three-generational sample. The sample consisted of 52 families — 26 parent and 26 grandparent — in the small town of Marshall in central Illinois. Parent families were selected on the basis of the ages and number of children, on the presence of both parents in the home, and on the presence of one set of grandparents in the community. Of the 26 grandparent families, half had daughters and the other half had sons in the parent sample.

Information was collected by one of the authors using an original questionnaire and the interview-questionnaire method.

Karen Schnittgrund is Instructor; Marilyn Dunsing, Professor; and Jeanne Hafstrom, Assistant Professor, all in Family Economics, Department of Home Economics.

Some characteristics of the 52 families are presented in the table. In addition, 22 of the grandparent families considered their income to be average and four considered their income to be above average when their children were growing up. Slightly less than a third of the grandfathers had blue-collar jobs; the rest had white-collar jobs. Half of the grandmothers had worked outside the home while their children were growing up.

The parent families' mean income before taxes was $10,200. Slightly more than three-fifths of the husbands were employed in blue-collar occupations; the others, in white-collar occupations. Forty-six percent of the wives worked outside the home.

Demagraphic Characteristics of 26 Grandparent and 26 Parent Families

Characteristic	Grandparents	Parents
	mean	*mean*
No. of years married	31.3	6.6
Husband's age, yr.	54.6	28.3
Wife's age, yr.	51.7	25.2
No. of children per family	2.8	1.5
Children's age, yr.	27.1	4.6
Husband's education, yr.	10.1	13.1
Wife's education, yr.	10.8	12.4

Allowances

Although nearly three-fifths of the grandparents felt that children should be given allowances, only about two-fifths of them had actually given allowances to their sons and daughters. Interestingly enough, if the sons and daughters had received allowances as children, their spouses also had usually received allowances. Conversely, if sons and daughters had not received allowances, neither had their spouses.

More parents than grandparents favored allowances for children. About four-fifths of the sons and daughters felt that children should be given allowances, and nearly three-fourths of their children were receiving allowances, or would do so when old enough. As might be expected, in nearly all the families where both parents had received allowances, the children also received or would receive them. However, children were also getting allowances in nearly half of the families where neither parent had received an allowance.

Parents' reasons for giving allowances included: to teach children the value of money; to have them learn responsibility; to teach them to budget and manage money; to have them learn to save; and to provide children with spending money. The reasons for not giving allowances included: money is given when the children need it; money is given for a job well done; and allowances are unnecessary.

The ages at which children began receiving allowances ranged from six to eight years, with the amount tending to increase with age. Allowances were given weekly. In most of the families, the children received additional money when they asked for it. Most of the children asked their parents for some guidance in spending their money, especially when large purchases were being made.

Payment for household jobs

Most of the grandparents (90 percent) felt that children should be expected to do some jobs around the house without being paid. However, slightly more than two-fifths of the

sons and daughters had been paid for doing specific jobs. These included painting, housework, farm work, and mowing the lawn.

Like the grandparents, most of the sons and daughters (98 percent), as well as all of the spouses, felt that children should do certain jobs without being paid. As with allowances, both parents in a family had usually received the same treatment as children when it came to being paid (or not paid) for doing household jobs. About three-fifths of all the parents had not been paid. Of these, one-third of the grandparents' sons and daughters and about one-fifth of the spouses felt that they were expected to do too much for no pay.

In five of the ten families with children old enough to be paid for extra household jobs, neither parent had been paid and they were not paying their children. However, in three other families, the parents had not been paid but they were paying their children.

Financial plans for education

Over four-fifths of the grandparents believed that parents should make financial plans for their children's education after high school. However, only half of the families had made such plans. Financial plans had been made for only about one-fourth of the spouses of the grandparents' sons and daughters.

Of all the parents for whom financial plans for an education had been made, four-fifths felt that these had been sufficient. Among those for whom plans had not been made, the sons and daughters of the grandparents often differed from their spouses in their attitude toward this lack of planning. Only about one-third of the sons and daughters, but somewhat over two-thirds of the spouses, wished that their parents had been more concerned about their education.

Like the grandparent families, most of the parent families (about 75 percent) favored making financial plans for their children's education beyond high school. Sixteen of the parent families had made such plans. This group included most of the parents who had had plans made for their own education, as well as six parents for whom no such plans had been made.

Family financial decision making

The grandparents, when compared to the sons and daughters and their spouses, were more in favor of letting children sit in on family financial discussions at an early age and also were more in favor of permitting both younger and older children to help make financial decisions for the family. However, among all three groups, letting children sit in on financial discussions received more approval than letting them help make decisions.

As might be expected from their attitudes, most of the grandparents (88 percent) had allowed their children to know the financial situation of the family and slightly over three-fourths had allowed their children to be present when family finances were discussed. Somewhat over half of their sons and daughters had helped to make financial decisions when they were children. Most of the spouses had sat in on family financial discussions as children, but only two had helped to make the family's financial decisions.

About three-fourths of all the parents who had taken part in family financial decision-making as children indicated that they had participated as much as they wanted to. Most of those who had not participated, however, felt that they should have been allowed to do so.

Six of the parent families had children old enough to be present at family financial discussions, and in three of these families the children were helping to make decisions. In two of the three families, the parents had also been allowed to help in the decision-making.

Like parent, like child

In general, the grandparents and their sons and daughters had similar attitudes on the major issues covered in this study. There was also a tendency for the parents to treat their children as they themselves had been treated.

On such items as allowances and financial plans for education after high school, fewer parents had had them than were providing them for their children. However, most of the grandparents indicated that they now approve of allowances and of financial plans for education. Since some of the parents grew up when incomes were much lower than now, money may not have been available for allowances or an educational fund. More information is needed about the effect of economic conditions on behavior patterns with respect to money practices and children; and also on the reasons why parents' attitudes change after their children are grown.

Generally the grandparents' sons and daughters and their spouses had similar attitudes. However, the sons and daughters were more likely than the spouses to feel that they had had everything they wanted as children. The spouses, as would be expected, were more likely to want more for their children than they themselves had received.

When both parents in a family had been treated about the same when children, they tended to treat their own children the same way. When the parents had been treated differently, their children usually received the same treatment that had been received by the parent who was a son or daughter of a grandparent family.

The actual practices followed by the grandparent and parent families were not always the same as their expressed attitudes. The parents' behavior may have been affected by the fact that many of the children were very young. Thus, a second study with the same type of sample, but with older children, who would also be interviewed, could provide more understanding of attitudes about money practices.

Another study, including parents who have moved from their community of origin, would provide valuable information about the influence of additional cultural factors on attitude formation.

PLATO: Computer-Assisted Instruction in Animal Breeding

M. GROSSMAN

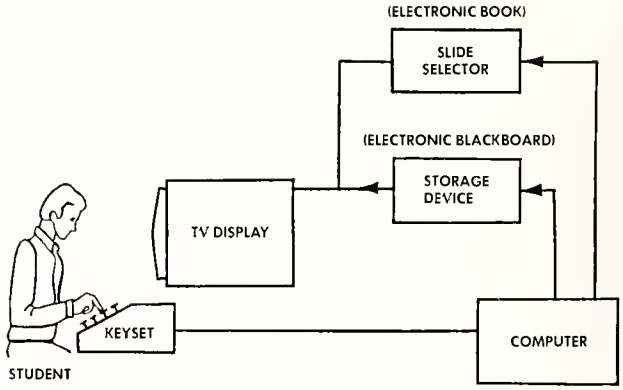


Diagram of PLATO III system. (Fig. 1)

With the aid of computers, teachers can provide individual instruction for far more students than was possible not so many years ago.

Perhaps the most versatile computer-based teaching system is PLATO (Programmed Logic for Automatic Teaching Operations), developed at the Computer-based Education Research Laboratory of the University of Illinois. PLATO permits a student to progress at his own rate, and also provides remedial instruction for students with insufficient preparation in the subject matter.

The PLATO system is especially well suited to a subject such as animal breeding, which involves logical reasoning based on complex mathematics. It is now being utilized in two laboratory lessons for undergraduates studying the mathematical principles of genetics and animal breeding. The lessons are coordinated with classroom lectures.

Description of system

The two lessons were programmed for PLATO III, the third version of the system, which can provide instruction for 20 students at once. PLATO IV, now being developed, will serve about 4,000 students and teach 300 courses simultaneously.

In PLATO III, each student has a television screen and a keyset on which he types his responses (cover picture). The television screen presents the written or graphic material programmed into the lesson. This material may be stored either in the central "electronic book" or in the student's individual "electronic blackboard" (Fig. 1). Images from both the book and the blackboard can appear on the screen at the same time.

The electronic book, shared by all student terminals, contains photographic slides presenting basic information. The blackboard, which receives the student's responses, is programmed with information for evaluating these responses. If a student's response is incorrect, he can press the "help" key for an explanation.

In addition, the computer stores a complete record of student responses on magnetic tape, so that the teacher can review each student's progress from a printed output.

Lesson on population genetics

One of the computerized animal-breeding lessons is on population genetics. It concerns the effects of three forces — mutation, migration, and selection — on the frequency of genes in a hypothetical population. Each force is studied independently to determine the influence of its components: number of generations, rate of the force, gene action, and initial gene frequency.

Before the lesson, the student receives a pictorial representation of the lesson, a brief written introduction to PLATO, and a guide to the laboratory exercise. Students have no difficulty using PLATO, even without previous experience.

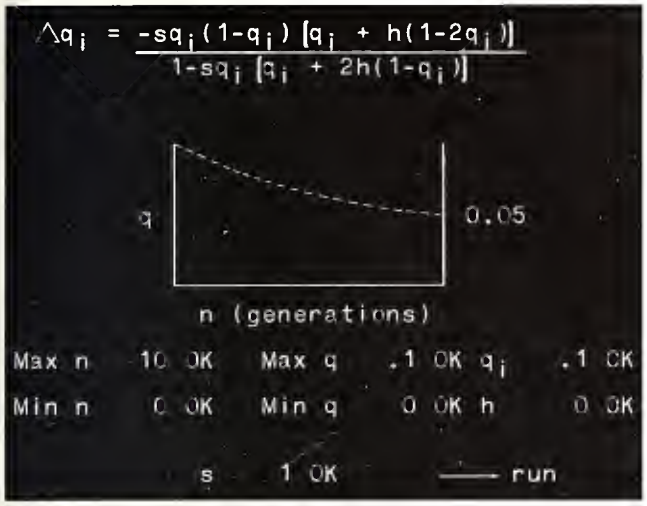
The lesson first introduces the student to a hypothetical animal population. A genetic description of the population is then presented in terms of a particular trait such as coat color. Next the student may see how each force operates in the herd to change the frequency of genes determining coat color. He chooses the force (mutation, migration, or selection) that he wants to study and is branched to one of the three subprograms. After completing a subprogram, he may choose another one.

Suppose the student wants to study the effects of selection on the gene frequency of a qualitative trait such as black or red coat color in Holstein-Friesian dairy cattle. First, he must demonstrate his understanding of the concept of selection by successfully working some genetic examples. If he is unsuccessful, he may ask PLATO for help, be diverted to a help sequence which reviews the concept, and return to the main unit of the lesson. At this point, the computational capabilities of PLATO are important, because the student can give his answer without being burdened by arithmetic. PLATO will do his calculations for him.

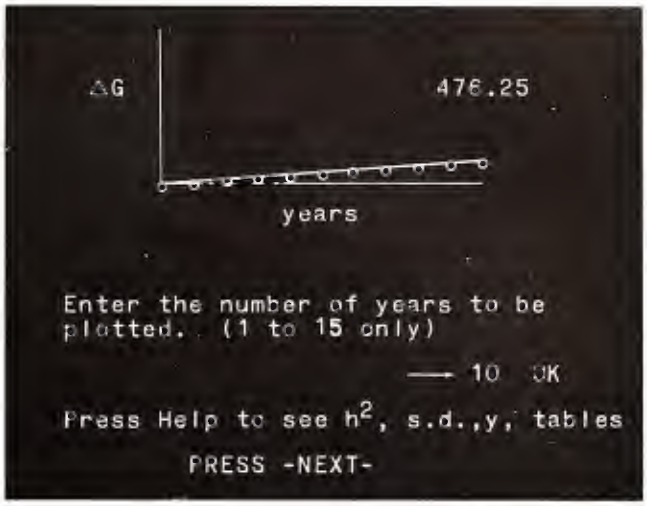
Each subprogram ends in a graph sequence so the student can discover the long-term effects of a force on gene frequency and can independently vary its components. For each graph, the student determines the scales on the axes by specifying the number of generations the force will be operating (Max n and Min n) and the range of gene frequencies (Max q and Min q).

In selection, the change in gene frequency after the i^{th} generation

M. Grossman is Assistant Professor of Genetics in Dairy Science. The programming of PLATO III was done by Darlene Chirolas, Graduate Research Assistant in Dairy Science.



Simulated results of selection for a qualitative trait, as shown on the TV screen. (Fig. 2)



A simulation of the results of selecting for a quantitative trait. (Fig. 3)

(Δq_i) can be shown theoretically to depend on the dominance relationship (h), the selection coefficient (s), and the gene frequency in the i^{th} generation (q_i). Suppose the gene to be eliminated is the recessive ($h = 0$) which, when homozygous, makes Holstein-Friesians red where black is preferred ($s = 1$) in the herd. Assume also that 1 percent of the initial population is undesirable ($q_0^2 = 0.01$; therefore $q_0 = 0.1$). Continued selection for 10 generations (about 50 years with dairy cattle) will reduce the percent of undesirables to 0.25 and will reduce the gene frequency by half ($q_{10} = 0.05$). (See Fig. 2.)

Through computer simulation of the results of selection, the student may vary h, s, and q_i independently to discover the relative importance of each component in changing the gene frequency.

Lesson on quantitative genetics

The object of the second lesson, on quantitative genetics, is to teach how the annual genetic gain for a particular selection method is influenced by its components: selection intensity, generation interval, relationship among family members, family size, and heritability.

The lesson first introduces the student to quantitative genetics, demonstrating how the phenotypic expression of genes tends to be continuous because of the effects of environment. The concept of heritability is reviewed with three simple illustrations.

The student is then ready to use PLATO to discover, through genetic simulation, how much each component of selection affects the annual rate of genetic gain. From a list of ten traits (two for each of five species: dairy cattle, chickens, swine, beef cattle, and sheep), he chooses a trait he wishes to change by selection. He next chooses among seven systems of selection (individual selection, selection on the average of multiple records, family selection, fullsib testing, halfsib testing, progeny testing, and individual-plus-family selection).

Suppose the student wants to compare selection for milk yield in dairy cattle based on individual first lactation performance with selection based on the average of multiple records. He first enters the names of the components involved: selection intensity (i), heritability (h^2), phenotypic standard deviation ($s.d.$), generation interval (y), number of records (m), and repeatability (c). (If he names the components incorrectly, he may branch to a help sequence that will show which components are needed.) He is provided with values of some components (h^2, $s.d.$, y, and c) but must supply the values for i and m.

By entering different sets of values, the student can discover for himself the best method of selection. PLATO will simulate and plot the genetic gain in each generation and give the result at the right of the graph. Because values of the components are constant, the genetic gain is linear.

The student learns that retaining the best two of ten cows results in a genetic gain of 476 kilograms of milk, simulated over 10 generations (Fig. 3). Selection on the average of two records results in a genetic gain of 426 kilograms; three records, 445 kilograms.

It is apparent that selection based on the first lactation is more efficient than selection based on the average of the first two lactations, assuming the same number of generations. Because the second lactation requires an additional year, it reduces the genetic gain per year. Using the average of three lactations is more efficient than using two lactations, but less efficient than using the first lactation alone.

More ground covered

Without PLATO, it is necessary to breed small animals in the laboratory to illustrate the principles of animal genetics. It might therefore take a whole semester to make a point that can be made in a minute by using the computational abilities of PLATO. The computer thus greatly increases the amount of ground a teacher can cover, as well as the number of students he can reach.

WINTER MELON

This easy-to-grow vine crop is low in calorie content

MEL CHIH-YU CHU

Fruits of four winter melon varieties: a, elliptical round; b, elliptical; c, oblate with heavy wax coating; d, an underdeveloped oblong giant fruit.

ALTHOUGH LITTLE KNOWN in the United States, the winter melon or wax gourd (*Benincasa hispida*) has long been popular in the Orient. The Chinese have been cultivating it for over 2,000 years.

Winter melon is a low-calorie food, containing only 13 calories per 100 grams of flesh (see table). Its taste is bland as it contains little sugar and acid. It is used in soups or is cooked with ham, pork, chicken, or beef; and it can also be used for making sugar-coated candies.

Much of the winter melon supply in the United States is imported from South America. The melons are sold mostly in China Town stores (the price in the fall of 1972 was 35 to 50 cents a pound). As they become better known in the United States, the market demand should increase, encouraging commercial production. They can also be easily grown in home gardens.

Nutrient Values per 100 Grams in Edible Portions of Winter Melon, Pumpkin, and Summer Squash[a]

Nutrient	Winter melon	Pumpkin	Summer squash
Energy, cal.	13	31	16
Protein, gm.	0.4	1.2	0.6
Fat, gm.	0.1	0.2	0.1
Carbohydrate, gm.			
Total	3.0	7.3	3.9
Fiber	0.5	1.3	0.5
Ash, gm.	0.3	0.8	0.4
Calcium, mg.	19	21	15
Phosphorus, mg.	19	44	15
Iron, mg.	0.4	0.8	0.4
Vitamin A, I.U.	0	3400	260
Thiamine, mg.	0.04	0.05	0.05
Riboflavin, mg.	0.11	0.08	0.09
Niacin, mg.	0.4	0.6	0.8
Ascorbic acid, mg.	13	8	17
Water, pct.	96.1	90.5	95

[a] Adapted from C. C. Hu: "Vegetable Crops" (in Chinese). 1966.

Plant characteristics

The plant is a trailing annual vine, hairy with five or more lobed, heart-shaped leaves. Flowers are solitary and yellow. Male flowers have a long stalk, but female flowers are almost stalkless.

Depending on the variety, fruits are oblate, globular, or oblong, with a heavy or light coating of wax on the skin when mature (see photograph). They may vary from 8 to 20 inches in length and from 6 to 12 inches in diameter. A mature oblong fruit of a giant variety may weigh as much as 50 pounds; smaller varieties may average about 5 pounds in fruit weight.

Growing, harvesting, and storage

The giant varieties are not suited to Illinois growing conditions, but several other varieties have been successfully grown both by the author at the Vegetable Research Farm, and by home gardeners to whom he gave some seedlings. Winter melon grows well in any well-drained soil, but best results are obtained on sandy loam.

Seed is available in most China Town food stores. Or you may just purchase a melon and save your own seed. In Illinois seeds should be germinated indoors at 75° to 85° F. in early April. Germination requires 10 to 25 days. Seedlings are transplanted in the field in late May, after the latest frost.

The melons will mature 80 to 120 days after transplanting, depending on the variety and the weather conditions. Cultivation practices are about the same as for pumpkin or squash. The crop is resistant to bacterial wilt, and no other diseases or serious insect pests have been observed on melons grown at the Vegetable Research Farm.

Melons reach maturity 40 to 50 days after fruit-set. For some varieties, a heavy wax deposit is the sign of maturity; for others, a dark green color.

Winter melons can be stored quite long without much change in quality. The author harvested some melons in early September and stored them in the greenhouse. They were still in good condition in April and looked as if they might last a year.

Cooking

Remove skin, seeds, and cavity contents. Unused portions of melon can be stored in a plastic bag in the refrigerator for several weeks.

Following is a simple recipe for melon soup (it serves four):

- 2 c. 1-in. melon cubes
- 1 16-oz. can chicken broth (or chicken bouillon cubes and water)
- ½ c. water
- ⅓ c. lean pork, ⅜-in. cubes
- ⅓ c. ham, ⅜-in. cubes
- 1 oz. mushrooms, whole or sliced
- 1 oz. small shrimp
- ⅓ c. bamboo shoot cubes (optional)
- ⅓ c. raw peanuts (optional)
- 1 piece ginger root (optional)

Combine all ingredients except melon and bring to boil. Add melon and enough additional water to cover the melon cubes. Return to a boil, then turn heat to low and cover soup. (Add salt to taste.) The soup is done when the melon cubes become translucent.

The melon may also be boiled and served as a side dish.

Mel Chih-Yu Chu is Assistant Horticulturist.

Effects of Herbicides on the Turfgrass Ecosystem

A. J. TURGEON

Herbicides developed within the past two decades have had a tremendous impact upon the management and quality of lawns. With these modern herbicides we can control crabgrass and nearly all the broadleaf weeds found in turf. If it were not for the difficulty of controlling weedy perennial grasses, one might conclude that there is a simple cure for every problem in lawn management with a beautiful lawn as the inevitable result. However, this is "medicine-cabinet" logic and, although popular, it shows ignorance of basic plant ecology.

A lawn is actually a complex and dynamic plant community, with many individual turfgrass plants existing in close association. In a good-quality lawn, plant density is extremely high and the plant community is uniform in texture, density, color, and growth habit.

As nature does not favor this perfect a monoculture, pests such as weeds, diseases, and insects can be anticipated. Although modern pesticides are important aids in dealing with these pests, the indiscriminate use of some pesticides has resulted directly or indirectly in the deterioration of turfs.

To understand the interaction of pesticides and turf, we need to view turf as more than just a plant community, but rather, as a higher level of ecological organization — an "ecosystem."

The turfgrass ecosystem

A plant community exists in intimate association with its environment. The environment includes all the factors which affect the plants and which, in turn, may be affected by the plant community. These factors are *climatic* (temperature, moisture, light, and wind); *edaphic* (physical, chemical, and biological properties of the soil); and *biotic* (cultural practices, chemical applications, animal and plant life, etc.).

This overall system — plants plus complex environment — is the turfgrass ecosystem. The interdependence of ecosystem components in a turf is most clearly evident in a mature lawn with no undesirable "thatch."

Thatch

Thatch is a tightly intermingled layer of living and dead leaves, stems, and roots of grass, which develops between the layer of green vegetation and the soil surface. Thatch in a turf results from an imbalance between two opposing forces — growth and decomposition. As long as organic-matter decomposition by soil-inhabiting organisms keeps up with the production of new organic matter, thatch does not develop. This is quite an amazing phenomenon since a lawn collects tremendous quantities of organic matter from clippings and from the death of leaves, stems, and roots.

The development of thatch more than ¼ to ½ inch thick is detrimental to a turf. The crown of the grass plant develops at the surface of the thatch; hence, new roots and rhizomes may develop within the thatch without growing very deep into the soil.

Turfgrasses growing in thatch are weaker and more susceptible to environmental stresses than those that are well rooted in soil. Thatch also harbors disease organisms, reduces water infiltration into the soil, reduces plant response to fertilization, and decreases the effectiveness of fungicides and insecticides.

Pesticides and thatch

Some insecticides have been reported to cause thatch accumulation in turf, especially after successive applications. To determine whether herbicides also encourage thatch when applied annually, a study of six preemergence herbicides was initiated in the spring of 1970. Although these herbicides had been tested extensively for their effectiveness against crabgrass, most studies did not include repeated applications. Yet home owners and professional turfgrass managers typically apply these materials year after year.

In the fall of 1971, after two annual applications of the herbicides, plots treated with bandane (35 pounds per acre) and calcium arsenate (392 pounds) had 1.4 to 2.0 centimeters of thatch. No thatch developed on untreated plots. Nor did thatch develop on plots receiving bensulide (15 pounds per acre), DCPA (15 pounds), siduron (8 pounds), or benefin (2 pounds).

After the third season, most of the roots and rhizomes in the bandane and calcium arsenate plots were confined to the thatch, with very little growth into the soil. Furthermore, no earthworms were found in the upper 3 inches of soil, although they were abundant in the upper soil profile of the other plots.

It is not known whether the thatch was due entirely to the absence of earthworms. However, it is obvious that these two chemicals did affect earthworms and also that they affected the turfgrass environment in a way that reduced turf quality. (Another example of bandane's effects was observed in Michigan, where stripe smut disease developed on Kentucky bluegrass that had been treated annually with this chemical.)

Turf management is not an exact science. Many of the contemporary cultural practices for turf were developed through trial and error, and the limitations of new materials will be better determined by further experience. Proper management of the turfgrass ecosystem includes the selection of pesticides that do not seriously upset its balance.

A. J. Turgeon is Assistant Professor of Turf Management. The experiment with herbicides and thatch was initiated by J. D. Butler.

EROSION FROM FEEDLOTS

Is Predicted by Adapting the Universal Soil Loss Equation

J. L. JESCHKE and D. L. DAY

A METHOD has been developed in the Department of Agricultural Engineering for predicting the movement of manure solids from unpaved cattle feedlots that are exposed to rainfall. The method was based on previous studies conducted in other states.

In one of these studies, W. H. Wischmeier of Purdue University developed the universal soil loss equation to predict the soil loss from any given area. The loss is expressed as a function of rainfall pattern, topography, soil, conservation practices, and combination of cropping and management.

The model for the equation is:

$$A = R \times K \times C \times L \times S \times P$$

A is average annual soil loss in tons per acre (oven-dry weight). R, the rainfall factor, is the localized expected value of the rainfall-erosion index. K, the soil erodibility factor, is soil loss, in tons per acre per unit of R, for a given soil and slope. C, the cropping-management factor, is the expected ratio of soil loss from land cropped under specified conditions to soil loss from cultivated continuous fallow on identical soil and slope and under the same rainfall. L, S, and P are factors for slope length, percent slope, and conservation practices, respectively.

We believed that the universal soil loss equation could be used to predict the loss of manure solids. The problem was to relate these solids to soil type and formulate a K factor for them. To do this, it was necessary to obtain values for annual losses of manure solids from unit plots, these being the standard testing areas used in formulating the soil loss equation.

A basis for predicting losses of manure solids was found in the rainfall-runoff equation developed by C. B. Gilbertson and co-workers at the University of Nebraska; and the runoff-solids loss equation developed by J. M. Madden and J. N. Dornbush at South Dakota State University. By combining these two equations, we developed a method for predicting the solids loss caused by a rainstorm.

Using this method and data collected in the Nebraska study, we calculated the annual solids loss from a feedlot. This value was then converted to a unit plot value. The K factor was calculated by dividing the total solids loss from a unit plot by the rainfall erosion index for the test area. A K factor of 0.16 was determined for beef cattle manure. (Erodibility values for soils may range from 0 to 1.) A work sheet was finally developed to simplify the calculations.

As an example of how the method can be used, assume that you want to calculate the annual solids loss from an uncovered, unpaved feedlot in central Illinois. It has a slope length of 200 feet on a 10-percent gradient.

In this example, R = 180 for central Illinois (R varies from 160 in northern Illinois to 220 in the southern part of the state). K = 0.16; C = 1 for feedlots; L × S = 1.9 (from chart); P = 1 for feedlots. Thus A equals 54.7 tons per acre, dry weight basis.

The method can be used not only for calculating erosion losses from existing feedlots, but also for comparing alternative sites for planning new feedlots. Also, it can be used for predicting losses from individual rainstorms. The equation may be applied to land-spread manure, but only as an aid in comparing various spreading situations; it needs further refinement before it can be used to determine actual losses.

This approach needs to be further verified with field studies under Illinois conditions.

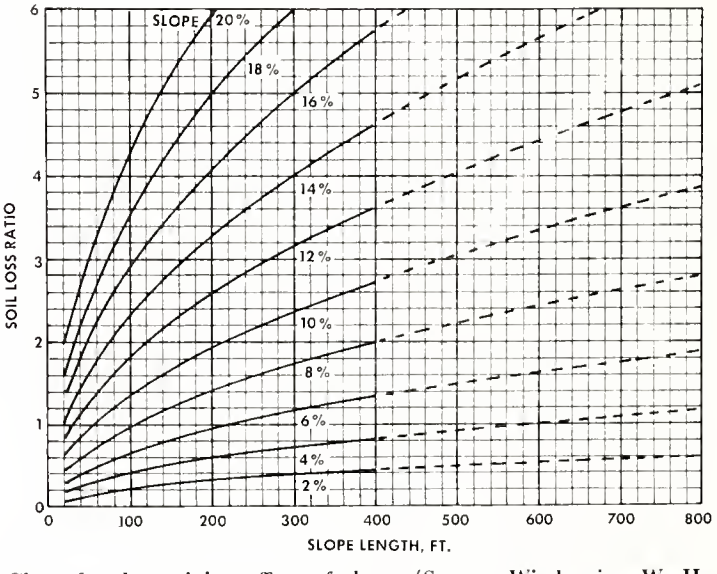


Chart for determining effect of slope. (Source: Wischmeier, W. H. A rainfall erosion index for a universal soil loss equation. Soil Sci. Soc. of America Proc. 23: 246-292. 1960.)

J. L. Jeschke was formerly a Research Assistant in Agricultural Engineering; D. L. Day is Professor of Agricultural Engineering. This report is based on an M.S. Degree thesis, Erodibility Factor of Beef Cattle Manure, written by Mr. Jeschke under Dr. Day's direction. The study was supported in part by the U.S. Environmental Protection Agency.

Five Staff Members Receive Funk Awards

Five College of Agriculture staff members received cash awards in the third annual Paul A. Funk Recognition Program on March 2. The awards are provided by the Paul A. Funk Foundation of Bloomington "to recognize outstanding performance and high achievement among the faculty of the College of Agriculture at the University of Illinois."

The five award winners, and the major reasons for which they were honored, are as follows:

Samuel R. Aldrich

Dr. Aldrich has earned high respect for his innovative applications of research results to Extension programs in soil fertility. He emphasizes an integrated crop production system strengthened by the interaction of fertility, tillage, varieties, and cultural practices.

Recently he planned and implemented a systematic statewide survey of plant and soil analysis. The results are a benchmark of the fertility status of soils and the nutritional status of corn and soybeans.

Under his leadership the Illinois Fertilizer Conference and regional meetings for fertilizer dealers have developed into a broad educational program on the nutrient needs of crops and soils.

A member of the Illinois Pollution Control Board, Dr. Aldrich has taken a realistic approach to environmental problems and has vigorously defended agriculture against unproven criticisms by environmentalists.

Marilyn M. Dunsing

Within a decade after Dr. Dunsing arrived on the University of Illinois campus, she had gained national recognition for her development of M.S. and Ph.D. programs in family and consumption economics. Similar programs are now proposed for universities throughout the nation.

In teaching the five courses that she has developed, she is noted for using up-to-date materials and methods, and for always having time to help and encourage her students.

Because of her research abilities, the Secretary of Agriculture appointed her to the Sub-Committee in Agricultural Science of the U.S. Department of Agriculture and to the Community-Family-Consumer Work Group to review social science research in Land-Grant colleges.

While never holding a formal Extension appointment, Dr. Dunsing has played an important role in expanding and improving the Extension program in family economics. She is the author or co-author of nearly 30 Extension publications.

Arthur L. Hooker

One of the world's leading corn pathologists and geneticists, Dr. Hooker has made significant contributions to world agriculture through his research, teaching, and assistance to the seed corn industry.

His most notable recent achievement — in 1970 — was to identify *Helminthosporium maydis* race T as the cause of southern corn leaf blight and to quickly determine that normal cytoplasm corn is resistant. In cooperation with the U.S. Department of Agriculture, he released resistant C and S male-sterile cytoplasms to the seed corn industry, greatly reducing the danger of future attacks by southern corn leaf blight.

In other research, Dr. Hooker has discovered superior forms of resistance to northern leaf blight and developed resistant parent material that is now widely incorporated in corn hybrids. He has also discovered several major forms of resistance to corn rust and has done extensive research on multigenic resistance to stalk rots.

Norman G. P. Krausz

Dr. Krausz is perhaps best known for his research and publications on the legal aspects of water use and the effects of taxation on agriculture.

His outstanding book on water use laws in Illinois is widely used, as are his publications on the use of rural areas for recreation; zoning to protect water supplies; and legal procedures and protections when farmlands are taken for public use. In addition, he is nationally known for research and publications on local, state, and federal taxes; business organization of the farm firm; inter-generation transfer of farmland; and corporate farming.

Dr. Krausz is also a popular lecturer on these subjects, having addressed an estimated 65,000 people at about 670 meetings in the state.

He organized the first class in agricultural taxation at Illinois and wrote the nation's first agricultural law casebook, which is now used at several other institutions. Students have four times named him the outstanding teacher in the Department of Agricultural Economics.

Robert G. F. Spitze

A commitment to education flows through Dr. Spitze's career of teaching, research, and public service in the field of economic policy. This commitment has carried him into positions of leadership at the departmental, college, university, and national levels.

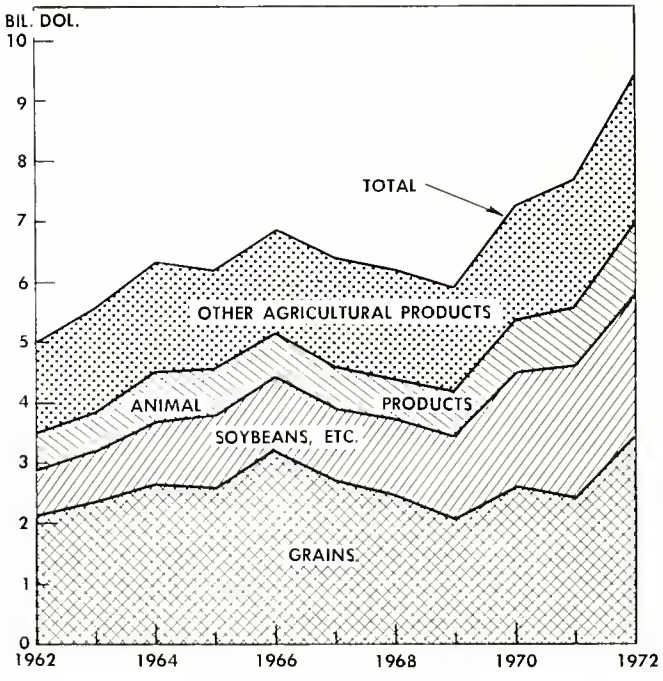
Enthusiasm characterizes his classroom teaching, counseling of students, advising of student organizations, and educational committee work. Innovative in his course offerings and teaching methods, he has been chosen for his profession's highest recognition for teaching excellence — the American Association of Agricultural Economics Undergraduate Teaching Award. He has also received the Alpha Zeta Award as best instructor in the College of Agriculture.

Dr. Spitze has gained national recognition for his publications on agricultural public policy. In his writing as in his teaching, he urges individuals to be informed and to participate in improving society.

FARM BUSINESS TRENDS

FOREIGN TRADE is becoming increasingly important to U.S. farmers, especially those who produce soybeans and grains. They are not only selling larger amounts of their crops in overseas markets, but they are becoming more dependent upon imported farm equipment and supplies made from imported materials. Thus farmers will be big losers if other groups succeed in imposing more restrictions on our international trade.

As shown in the chart on this page, the value of agricultural exports increased from $5 billion in 1962 to $9.4 billion in 1972. Exports will be even larger this year because of the large sales made to Russia and other countries.



Exports of U.S. Agricultural Products, 1962-1974.

Sales of grains and grain products increased from $2.2 billion in 1962 to $3.5 billion in 1972. Exports of soybeans, soybean oil, soybean meal, and similar products increased from $725 million in 1962 to $2.4 billion in 1972. Exports of animal products — hides, meats, animal fats, dairy products, poultry and eggs — went up from $578 million to $1.1 billion. And the value of other agricultural products shipped to overseas markets increased from $1.6 billion to $2.4 billion. These other products included tobacco, cotton, fruits, and vegetables.

Exports of corn and corn products last year were equivalent to about 925 million bushels, which was around 30 percent of the corn that was sold by farmers. Exports of soybeans, including meal and oil, totaled about 600 million bushels, equal to 47 percent of the production in 1972. Shipments of wheat, including wheat products, were equivalent to 840 million bushels, or 54 percent of the crop harvested. Rice exports totaled 4,484 million pounds, or 80 percent of the production in 1972.

A large and increasing share of the farm equipment and supplies used by farmers is made from imported materials. Fuels and steel products are good examples. About one-fifth of our steel comes from foreign mills. Furthermore, one-third of the iron ore used by our own steel mills is obtained from other lands. And one-third of our motor fuels and heating oils is made from petroleum from foreign wells. The U.S. must export in order to pay for imported products. — *L. H. Simerl, Professor of Agricultural Economics*

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Plants grown in containe need the proper proportion of soil and soil amendmen for adequate water and aer ation (page 16).

COLLEGE OF AGRICULTURE Volume 15, Number 3

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

Summer, 1973 Volume 15, Number 3

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TWO STUDIES ON RETURNS FROM RESEARCH

VISIBLE RETURNS to the public from an investment in agricultural research sometimes accrue slowly, but once they start appearing they are extremely important to the national welfare. The time lag on returns has been attributed to producers' delay in adopting new practices. However, delay in adoption of biologically based new practices is just as likely to be due to the time needed to develop adjunct necessary services for widespread use of new technology.

For several years the Illinois Agricultural Experiment Station has been interested in determining the long-time benefits of research, particularly that which is supported with public funds. One study, which concerns the economic gains from research on corn, is discussed on the following page. It was conducted by a committee from the Departments of Agricultural Economics and Agronomy.

In another study, staff members from Dairy Science and Agricultural Economics have examined the benefits from research on dairy cattle during the last 30 years or so. This research included two major efforts (to which Illinois scientists made important contributions) by the agricultural experiment stations: (1) The genetics and inheritance of milk production were intensively studied, and the resulting knowledge was put to work by use of artificial insemination. (2) Major improvements were developed in the feeding and management of dairy cows, with a consequent increase in the efficiency of milk production.

As a result of this research, the nation's milk cow herd was cut in half from 1940 to 1970, while the national annual yield of milk per cow was doubled. During the same time period, the amount of total feed nutrients used for milk production decreased significantly, resulting in a saving of 5 to 10 cents on every gallon of milk sold.

— *G. W. Salisbury*

Benefits Stem From Research On Corn Production

S. W. WILLIAMS, S. STRONG, and C. B. BAKER

FOOD PRICES soaring far higher than they are now? And agriculture making a much greater demand on the environment and on fossil fuels? Such would be the situation today without the contributions made by agricultural research during the past 20 years or so.

Research on corn has enabled Illinois farmers to more than double their production of this crop during the past two decades. They have done this with only a slight increase in corn acreage, with a sharp reduction in the use of labor, and without equivalent increases in expenditures for fertilizer, machinery, and other items of production.

We recently calculated the benefits of the increased efficiency in corn production — both in Illinois and in the country as a whole. In comparing current production with that of 20 years ago, we used three-year averages wherever possible. This reduces the effects of year-to-year fluctuations in acreage and yield.

Effects on cost, acreage, and volume of corn production

If corn had continued to be produced with the techniques and average yield of 1949-1951, the volumes produced in the early 1970's would have required twice as much acreage as was actually harvested. About five times as much labor would have been needed and machinery inputs would have been about half again as large. Considerably less commercial fertilizer would have been used, but savings on that item and on herbicides would have been small compared with the added costs for other items of production.

Accordingly, by 1969-1971 producing corn with current technology rather than 1949-1951 technology resulted in a calculated saving of about $575 million a year in Illinois. This figure would have been much larger if the 1970 crop had not been greatly reduced by southern corn leaf blight. Savings were about $900 million each in 1971 and 1972. Use of the newer technology released nearly 10 million acres of land, most of which was used for soybeans, a crop that had a gross value of $914 million in Illinois in 1972.

During the 1950's and 1960's average corn yield per acre increased proportionally more in the United States as a whole than in Illinois — mainly because of increasing concentration of corn production in the North Central states, where yields are relatively high. Consequently, we may assume conservatively that the saving per bushel from use of the newer technology in the early 1970's was fully as large in the country as a whole as in Illinois. Since the nation's corn production is about five times that of Illinois, calculated national savings were roughly $4.5 billion per year in 1971 and 1972.

With use of the newer technology, about 50 million acres of land were released from corn in the United States. As in Illinois, much of this land was used for soybeans. The national value of the soybean crop was nearly $4.5 billion, indicating that the resources released from corn (including not only land, but also labor, machinery, and other inputs) have been effectively used in soybean production.

Effects on livestock products

Aside from these direct effects, improved efficiency in corn production indirectly has affected supplies and prices of meat, milk, and eggs. If corn production techniques had not improved during the past two decades, recent crops probably would have been much smaller than they actually have been. Reduced supplies and higher prices for corn, which is the leading concentrate feed, would have sharply curtailed livestock production and resulted in substantially

The authors, all in the Department of Agricultural Economics, are members of a committee evaluating the economic effects of corn improvement research. Other members are S. R. Aldrich and D. E. Alexander, Department of Agronomy; and L. D. Hill, G. G. Judge, T. Takayama, and J. Craven, Agricultural Economics. This paper is a progress report.

higher prices for meat, milk, and eggs.

To illustrate this, we estimated the effect upon meat supplies and prices if farmers had used 1949-1951 technology to produce corn on the 1971 acreage. If the 1971 acreage had yielded at the 1949-1951 level, the reduced quantity of corn available for feed would have cut supplies of pork and broilers by about one-third, and all meat by about one-fifth. These reductions in supplies would have raised the price of pork roughly one-fourth and of broilers by roughly one-half. In short, meat prices in the United States would have resembled meat prices common to much of the rest of the world.

With reduced supplies of corn, exports might have been greatly reduced or eliminated. Even if that had occurred, the effects on meat supplies and prices would have been about the same as we have indicated.

Role of publicly supported research

In the year ending June 30, 1971, about $15 million was spent for publicly supported research on corn production in the United States. This is much less than 1 percent of the direct annual benefits from increased efficiency in corn production. (A similar relationship of costs to benefits has been found in other studies of the returns from research, as reported by W. L. Peterson in *Resource Allocation in Agricultural Research,* University of Minnesota Press.)

Despite the relatively small amount of public money spent for corn research, scientists in state and federal research institutions do much of the research that makes it possible for corn producers to increase their efficiency. Here are a few examples of recent contributions by publicly supported agencies:

Corn breeders have done basic research on disease resistance in corn; have developed high-oil and high-lysine corn; and have devised a genetic male sterile system to supplant the obsolete cytoplasmic-sterile system in producing hybrid seed corn. Agronomists have provided underlying research on soils, the nutritive needs of crops, and rates and methods of fertilizer application, including techniques for applying anhydrous ammonia, which are basic to modern fertility programs.

Effective use of herbicides and insecticides rests upon research about weeds and insects, including their life histories, the injuries they do to corn, and the best times to control them. State and USDA agricultural engineers have developed prototypes of reduced-tillage equipment, picker-shellers, and equipment for applying herbicides and insecticides effectively at reduced levels.

Agro-industries serving corn producers have applied this research to increase productivity and conserve critical natural resources. For example, hybrid corn firms use principles and improved genetic lines developed by college and USDA geneticists to breed higher yielding and better standing hybrids. Plant nutrient needs identified by college research have been used by the fertilizer industry to develop highly efficient production and distribution systems for anhydrous ammonia, liquids, and dry bulk-applied fertilizers. On the basis of information provided by public research, chemical companies have developed increasingly effective corn herbicides and insecticides. Using ideas that originated in the agricultural colleges and USDA, farm machinery manufacturers have devised new machinery for reduced tillage and for harvesting, drying, and storing corn.

Besides providing basic information used by agro-industry, research has generated much information of direct value to the farmer. For example, such practices as earlier and thicker planting and heavier fertilization have been shown to increase yields; and the practicality of reduced tillage has also been demonstrated. Using the materials and machinery made possible by research, plus the recommended management and tillage practices, growers have been able to produce corn at relatively low cost in the face of rising input prices.

The newer technology which has grown out of the underlying research of publicly supported agencies has provided major public benefits, particularly in five respects:

- Consumers have enjoyed more and much less expensive meat, milk, and eggs than would have been available otherwise.
- Vast savings in soil resources have resulted from the intensified production of corn on land that generally is least subject to erosion and also from the use of reduced tillage.
- Higher acre yields and reduced tillage have held down consumption of fossil fuels.
- Efficient production has provided products for international trade, and brought in needed foreign exchange.
- Land released from food production as a result of higher acre yields is available for recreational uses and wildlife habitat.

The corn story is but one of many success stories that could be told about the benefits of agricultural research. Yet public support for future research is seriously threatened.

The productivity of agricultural research is made possible by an accumulation of knowledge and scientific expertise brought together in the nation's agricultural experiment stations and USDA. Should the support for such research decline, the nation's consumers would be the first to suffer. The effects would arrive quickly. But recovery — assuming that support would one day be restored — would be slow and costly. It would require reassembling the research and development system so carefully evolved over the past 100 years.

Indeed, what is needed is expanded public support rather than less. The human and social adjustment required by technical changes in agricultural production have hardly been studied, to say nothing of policy alternatives for encouraging more efficient adjustments. Research in these areas as well as continuing research on agricultural production, is basic to the future well-being of the nation.

ROOT PENETRATION IN SOILS With Contrasting Textural Layers

J. B. FEHRENBACHER, B. W. RAY, J. D. ALEXANDER, and H. J. KLEISS

In large areas of Illinois, soils were formed from materials that had a relatively uniform texture in the upper 3 to 5 feet. These materials were either loess (wind-blown glacial deposits) or glacial till deposited directly by glaciers with little sorting.

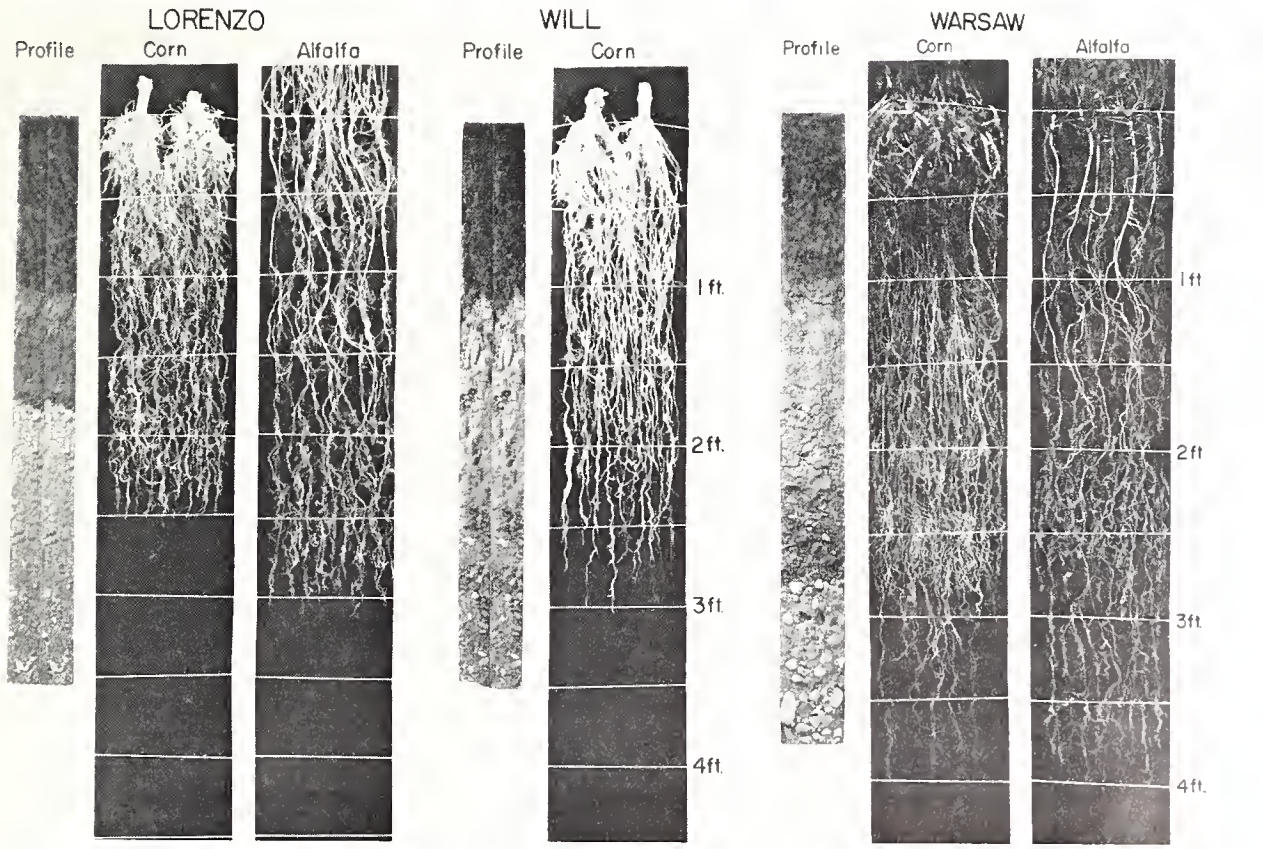
Other soils, however, were formed from materials that had much less vertical uniformity in texture. This uneven texture is characteristic of glacial outwash and bottomland areas where soil materials were deposited by water.

In many outwash and bottomland areas we often find soils that have strongly contrasting texture within the rooting depth of our common farm crops. For example, we may have medium-textured silt loams or fine-textured clays over sand or gravel in some areas, and sands or sandy loams over finer textured materials in others. Many combinations of textures are possible, but usually the finer-textured materials overlie the coarser ones. Soils with coarse-textured materials such as gravel at shallow depths are more common in outwash areas in northeastern Illinois than in other parts of the state.

Variations in texture greatly affect a soil's ability to store water that is usable by plants. Gravel and sand, for example, hold very low amounts of usable water.

For several years we have studied the rooting habits of corn and alfalfa on outwash and bottomland soils in widely separated areas ranging from McHenry County on the Wisconsin border to Alexander

J. B. Fehrenbacher is Professor of Pedology; B. W. Ray and J. D. Alexander are both Associate Professors of Pedology; H. J. Kleiss was formerly Research Assistant.



Corn and alfalfa roots in soils having gravel and sand layers at shallow depths. (Fig. 1)

Table 1. — Soils and Crops Studied and Root Penetration Into Underlying Material

Soil series	Underlying material	Crop	Root penetration, in.	
			Total	U.M.[a]
Outwash soils				
Lorenzo	Gravel & sand below 22″	Corn	30	8
		Alfalfa	36	14
Will	Gravel & sand below 31″	Corn	36	5
Worsaw	Gravel & sand below 33″	Corn	46	13
		Alfalfa	48	15
Billett	Sand & gravel below 65″	Corn	60	0
Ade	Sand below 62″	Corn	54	0
Bottomland soils				
Ware	Very fine sandy loam below 45″	Corn	48	3
Riley	Very fine sandy loam below 46″	Corn	58	12
Bowdre	Very fine sandy loam below 28″	Corn	42	14

[a] Penetration into underlying material.

County in extreme southern Illinois. One specific question that we wanted to answer was: To what extent do roots of these plants penetrate a gravelly or sandy layer underlying medium- or fine-textured materials at shallow depths? In other words, are the coarse-textured layers a barrier to root penetration as has often been thought?

So far root penetration on five outwash soils and three bottomland soils has been studied. Outwash soils included well-drained Lorenzo and poorly drained Will soils in McHenry County; well-drained Warsaw in Will County; well-drained Billett in Lawrence County; and well-drained Ade in Mason County. The three bottomland soils were all located in Alexander County. They included the well-drained Ware and the imperfectly drained Riley and Bowdre. Studies were conducted in well-managed farm fields with adequately fertilized soils. Growing seasons were favorable.

Soils and crops studied are presented in Table 1, together with a summary of the depths of root penetration. Particle size distribution in the major horizons of the eight soils is given in Table 2. Also shown in this table are the calculated water storage capacities in the various horizons. It is apparent that soil horizons high in silt and moderately high in clay can hold much more plant-available water than can sandy or gravelly layers.

Photographs of soil profiles and rooting systems are shown in Figures 1 through 3. Comparing these illustrations with the tables, we see that corn and alfalfa roots can penetrate into gravelly and sandy underlying materials to some extent. This is particularly true of well-drained soils such as Lorenzo and Warsaw (Fig. 1). Roots penetrated 8 to 15 inches into the underlying layers of these soils.

In the poorly drained Will, roots penetrated only about 5 inches into the underlying gravel and sand. This may have been due to a rather high water table through most of the 1968 season, when measurements were made.

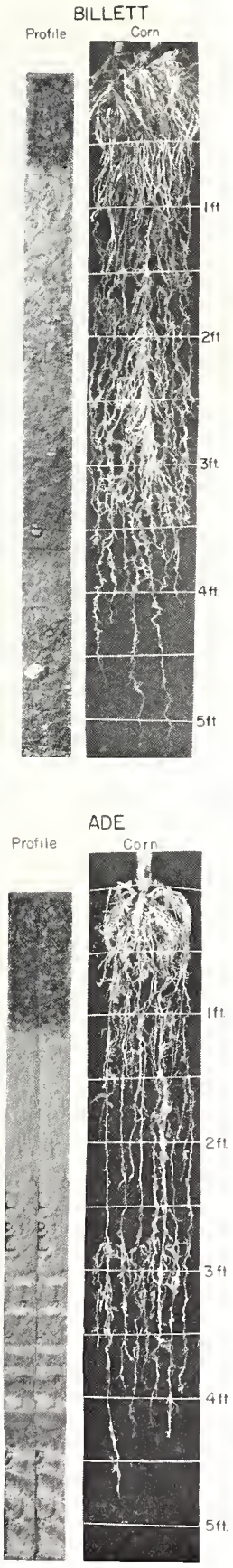
Coarse-textured sand and gravel were at a depth of 65 inches in Bil-

Table 2. — Particle Size Distribution of Soil Horizons on Total Soil Basis

Soil series and horizon	Gravel, pct.	Sand, pct.	Silt, pct.	Clay, pct.	Textural class[a]	Water, pct.[b]
Lorenzo						
A horizon 0-12″	0.6	56.9	25.6	16.9	sl	9.2
B horizon 12-22″	26.0	42.3	14.8	16.9	g scl	5.8
Underlying material below 22″	51.0	44.8	3.0	1.2	g & s	1.5
Will						
A horizon 0-10″	0.3	12.2	55.5	32.0	sicl	15.4
B horizon 10-31″	3.8	11.5	59.3	25.4	sil	13.6
Underlying material below 31″	53.0	38.2	6.1	2.7	g & s	3.8
Warsaw						
A horizon 0-12″	Trace	3.8	71.4	24.8	sil	19.6
B horizon 12-33″	14.8	14.3	38.7	32.2	sicl	12.9
Underlying material below 33″	62.8	28.4	7.1	1.7	g & s	5.6
Billett						
A horizon 0-9″	0.5	63.3	26.9	9.3	sl	10.4
B horizon 9-65″	15.0	69.7	7.8	7.5	sl to ls	3.8
Underlying material below 65″	43.2	53.6	2.5	0.7	s & g	1.3
Ade						
A horizon 0-11″	Trace	74.3	15.5	10.2	sl	5.6
B horizon 11-33″	Trace	91.3	3.7	5.0	s	1.7
B horizon 33-62″						
Clay-iron bands	Trace	91.6	2.1	6.3	s	2.0
Material between bands	Trace	93.2	2.4	4.4	s	1.6
Underlying material below 62″	Trace	96.9	1.1	2.0	s	0.8
Ware						
A horizon 0-10″	0	10.4	67.0	22.6	sil	15.3
Upper B horizon 10-26″	0	5.7	79.6	14.7	sil	14.1
Lower B horizon 26-45″	0	27.3	65.1	7.6	sil	7.1
Underlying material below 45″	0	51.0	43.2	5.8	vfsl	2.6
Riley						
A horizon 0-12″	0	45.9	33.1	21.0	l	12.2
Upper B horizon 12-26″	0	57.0	23.2	19.8	vfsl	8.9
Lower B horizon 26-46″	0	88.6	8.0	3.4	vfs	1.0
Underlying material below 46″	0	61.6	33.3	5.1	vfsl	2.8
Bowdre						
A horizon 0-13″	Trace	14.8	42.4	42.8	sic	11.7
Upper B horizon 13-18″	0	18.0	35.6	46.4	c	13.4
Lower B horizon 18-28″	0	68.9	14.4	16.7	fsl	7.3
Underlying material below 28″	0	70.0	22.6	7.4	vfsl	4.5

[a] Textural class: c = clay; fsl = fine sandy loam; g = grovel; g scl = grovelly sandy clay loam; l = loam; ls = loamy sand; s = sand; sic = silty clay; sicl = silty clay loam; sil = silt loam; sl = sandy loam; vfs = very fine sand; vfsl = very fine sandy loam.

[b] Water available to plants.



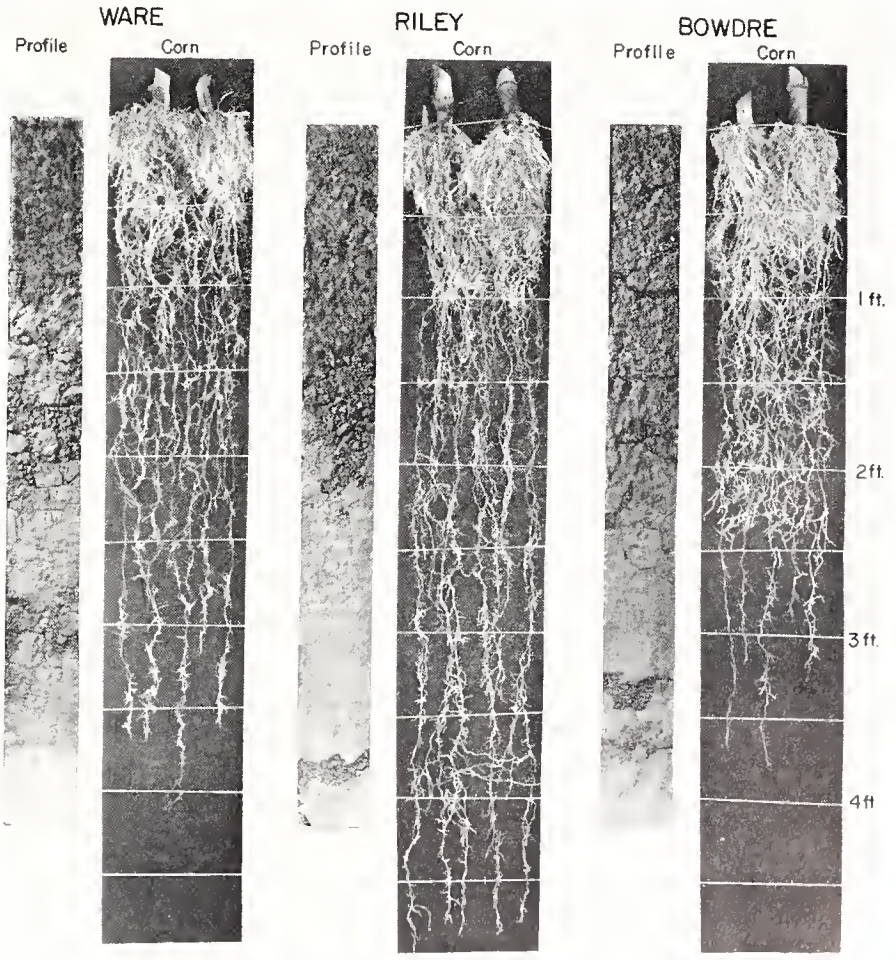
lett — too deep to have much influence on corn root penetration (Fig. 2). Ade was a very sandy soil with slightly finer textured clay-iron bands beginning at 33 inches. Root branching and growth was greater in the banded zone than in the immediately overlying sand layer.

Soil textures were not as sharply contrasting in the Ware and Riley soils as in some of the other soils. Riley had a silt lens at about 45 inches, which caused an increase in lateral branching (Fig. 3). The Bowdre soil, which had 18 inches of silty clay and clay overlying fine sandy loam and very fine sandy loam, showed a definite reduction in root concentration below a depth of about 28 inches (Fig. 3).

It appears that, under Illinois conditions, corn and alfalfa roots can penetrate thin layers of gravel and sand that occur fairly high in the soil profile. However, the roots will not penetrate thick layers of these materials, particularly if there is a high proportion of gravel. The large pore spaces between gravels hold little moisture if there is free underdrainage, and thus do not offer a very favorable environment for roots.

If roots do extend through layers of sand, such as in the Ade soil from 11 to 33 inches, and enter a somewhat finer textured layer (banded zone), they usually branch more profusely and take advantage of the increase in stored moisture and nutrients.

Corn roots in two predominantly thick sandy soils. (Fig. 2)



Corn roots in medium- to fine-textured bottomland soils underlain by very fine sandy loam layers. (Fig. 3)

Substitutes for Soybean Meal in Swine Rations

JOHN T. SCOTT, JR.
and C. T. CHEN

As everyone knows, soybean prices have recently risen much more than corn prices. This has caused a sharp shift in the price relationships of carbohydrates and proteins in livestock rations.

Because of this shift, we have recalculated the cost and value of substituting high-lysine corn in the traditional corn-soy hog rations used in the Corn Belt. (Our initial study on this subject was published in the Fall, 1967, issue of Illinois Research.) We have also evaluated the economics of including some of the new synthetic amino acids in the ration.

1967 vs. 1973 prices

In 1967 regular yellow corn was costing about $1.25 a bushel while soybean meal was around $80 per ton. At these prices we reported that high-lysine corn could sell for as much as $1.32 a bushel and still be an economical replacement for some or all of the regular corn and part of the soybean meal. The corn producer could profitably shift to high-lysine corn if it yielded at least 95 percent as much as regular corn.

Since 1967, regular corn prices have risen 50 percent or more and are about $2.00 a bushel at this writing. However, prices of soybean meal and other natural protein sources are 300 percent or more above 1967 levels.

Many factors help to account for this large advance in protein prices. Most important is the fact that world demand is increasing with growing population and rising income, while supply has not kept pace with demand. Field losses in our own soybean crop last fall, and the small Peruvian fish catch of the past two years are two major reasons for the lagging supply.

John T. Scott, Jr., is Professor of Farm Management; C. T. Chen, Research Assistant in Agricultural Economics.

Other protein sources

Other sources of protein are being developed. The Japanese have been leaders in this endeavor, partly because they must import so much of their food and are literally dependent on others for their life bread.

One approach, still in the experimental stage, has been to grow one-celled animals which eat crude oil. These animals are then harvested and processed as a protein source.

Another approach is to chemically synthesize the various amino acids. Methionine has been synthesized in this country and in Japan for a number of years and is used commercially in poultry rations. However, methionine has not been a problem in hog rations made basically from corn and soybean meal.

Two other amino acids — lysine and tryptophan — pose much more of a problem for swine nutrition, for ordinary yellow corn does not contain as much of these nutrients as swine need. Both are now being synthesized. Lysine, which has been synthesized longer than tryptophan, can be purchased for about $1.10 a pound. Tryptophan costs about $15.00.

As synthetic processes become more efficient and plant capacities increase, these prices are likely to decline. It is then conceivable that swine rations can be made cheaper with essentially no natural protein sources other than those found in corn. Even now, according to our calculations, it would be profitable to include synthetic lysine in the ration with appropriate reduction of soybean meal. And if the price of tryptophan could be reduced by only about a third, it too could be profitably used in the swine ration, virtually eliminating the need for soybean meal or other natural protein supplements at their current high prices.

High-lysine corn (also called Opaque-2 or modified protein corn) is still the best potential substitute for regular yellow corn and soybean meal in swine rations. It contains relatively high amounts of tryptophan, as well as lysine. In fact, both of these amino acids are in about the right proportions to furnish all the amino acids needed in the swine finishing ration, though not quite all that are needed in baby pig and growing rations.

Opaque-2 corn has not received the impetus we expected when we first investigated its use in swine rations five years ago. However, the great jump in protein costs has occurred fairly recently, and this unique corn variety may now receive more attention. More research is needed for improvement of yield and other characteristics.

Standard rations studied

We have recently rerun our minimum-cost linear programs for the traditional 12- and 16-percent crude protein swine rations with standard amino acid levels. (The 12-percent crude protein ration is normally used for finishing; the 16-percent, for growing pigs.)

The prices used in our calculations were those current at the time: $1.60 per bushel for regular yellow corn and $225 per ton for soybean meal. Although prices have advanced still

Table 1. — Swine Ration Alternatives for 12- and 16-Percent Crude Protein Levels

Type of ration	Ingredients in pounds[a]						
	Regular corn	Opaque-2 corn[b]	Soybean meal	Lysine	Trypto-phan	Dical	Lime
12 percent crude protein							
Standard corn-soy	88.89	...	9.75	...	...	.61	.75
Opaque-2 corn-soy	...	95.60	2.97	...	...	.74	.69
Corn-synthetic amino acid	90.93	...	7.63	.06	...	.65	.73
16 percent crude protein							
Standard corn-soy	79.23	...	18.70	...	...	1.01	1.06
Opaque-2 corn-soy	...	84.45	13.42	...	...	1.11	1.02
Corn-synthetic amino acid	80.35	...	17.54	.03	...	1.03	1.05

[a] The basic ingredients, corn and soybean meal, were priced at about $1.60 per bushel and $225 per ton, respectively. We assume that appropriate amounts of trace minerals, vitamins, and antibiotics are added where needed.
[b] Opaque-2 corn with high lysine and tryptophan.

Table 2. — Swine Ration Alternatives With Amino-Acid Requirements the Same as in the Standard 12- and 16-Percent Crude Protein Rations, but Without Minimum Crude Protein Levels Specified

Type of ration	Ingredients in pounds[a]						
	Regular corn	Opaque-2 corn	Soybean meal	Lysine	Trypto-phan	Dical	Lime
Amino acid levels of 12-percent crude protein ration							
Standard corn-soy[b]	88.89	...	9.75	...	...	.61	.75
Opaque-2 corn-soy	...	97.83	.70	...	...	.79	.68
Corn-synthetic amino acid	98.00	...	.26	.26	.01	.80	.67
Amino acid levels of 16-percent crude protein ration							
Standard corn-soy[b]	79.23	...	18.70	...	...	1.01	1.06
Opaque-2 corn-soy	...	85.74	12.11	...	...	1.14	1.01
Corn-synthetic amino acid	82.93	...	14.85	.10	...	1.08	1.03

[a] See footnote a, Table 1.
[b] The standard 12- and 16-percent crude protein rations are repeated here for ease of comparison.

further since then, the ratio of corn and meal prices has remained about the same, so that our results would be little changed.

We found that neither modified protein corn nor synthetic amino acids will meet all the amino acid requirements as well as the stipulated crude protein levels. However, these ingredients can replace a substantial proportion of the soybean meal if the price is right (Table 1).

With the present price relationships between corn and soybean meal, modified protein corn would be worth about 11 percent more than regular corn when used in the amounts shown in Table 1. Thus, if regular corn is priced at $1.60, Opaque-2 corn would be worth about $1.78. With regular corn at $2.00, Opaque-2 would be worth $2.22.

Assuming about the same production costs per acre, modified-protein corn needs to yield only about 90 percent as well as regular yellow corn to be attractive to hog producers. Thus, even without any increase in relative yield, modified-protein corn becomes a more feasible alternative to yellow corn than it was only a few years ago.

If we hold to the standard crude protein levels in formulating swine rations, synthetic amino acids would not be used at their current prices. For synthetic lysine to be used in the ration as shown in Table 1, the cost would have to be reduced to 20 cents a pound.

Amino acids as criteria

The use of synthetic amino acids becomes much more feasible if we consider only the standard levels of these protein building blocks and do not require additional minimum levels of crude protein. This would be in line with the thinking of a number of swine nutritionists who believe that the amino acid levels are what is important rather than the crude protein level.

Results of formulating a ration according to the amino acid levels are shown in Table 2. Here we found that, with current prices of corn and soybean meal, it would be profitable to use synthetic lysine at prices up to $2.10 a pound or about twice its present cost. Tryptophan, however, would have to be reduced from its current price of $15.00 a pound to $9.90 a pound before it would be profitable. Assuming this price for tryptophan, almost all the soybean meal in the finishing ration could be replaced with regular yellow corn and synthetics.

In the growing ration, even with synthetics available, there is still about three-fourths as much soybean meal as in the standard 16-percent crude protein ration. A check of the linear programming output indicates that the methionine requirement is holding soybean meal in the ration.

Some swine nutritionists believe that the traditional methionine requirement is too high. If so, it is likely that synthetic lysine and tryptophan could replace most of the soybean meal in the growing ration as well as in the finishing ration.

Without the specific crude protein requirements, almost no supplemental protein source is needed when Opaque-2 corn is fed in the finishing ration. The amount of soybean meal included in the ration is due to the traditional methionine standard, which is now believed to be outdated.

Substitutions feasible

It is clear from our work that it is now feasible to consider growing modified-protein corn for swine rations if you expect the yield to be at least 90 percent of regular corn yield. Use of synthetic lysine also can be profitable at present prices; and if the price of synthetic tryptophan can be reduced below about $10 a pound, then most of the natural protein supplements can be replaced with synthetic amino acids.

Double Cropping Soybeans In Small Grain Stubble

G. E. McKIBBEN and M. G. OLDHAM

In the midwest, double cropping usually means harvesting two crops a year on the same acreage: a small grain that was planted the previous fall, and a second crop planted after the grain harvest.

Although rye or barley may be grown as the small grain, wheat is the best bet. It generally outyields the other two grains, and a well-fertilized wheat crop will normally hold weeds in check until combining. For the second crop, farmers interested in cash grain will usually choose soybeans; those wanting livestock feed will likely grow either grain sorghum or corn.

Another sequence occasionally used is to follow a hay crop with corn, sorghum, or soybeans. However, the hay may exhaust the moisture supply, and it doesn't provide much mulch for the second crop. A mulch is important for reducing evaporation.

A zero-till system increases the chance for successful double cropping. The second crop can be established in the small grain stubble with no tillage other than planting. This reduces many of the problems associated with preparation of a seedbed for the second crop.

The success of zero-till double cropping is enhanced by: (1) an excellent stand of well-fertilized small grain which controls weeds until it is harvested; (2) early removal of the small grain to increase the chances for maturity of the second crop; (3) a proper combination of herbicides; (4) correct cultural techniques, including narrow-row spacing and high plant populations (with soybeans); (5) a variety of the proper maturity; (6) sufficient moisture; and (7) adequate fertility.

A successful second crop will increase the amount of nutrients removed during a year. The necessary fertilizer can be applied for the second crop before it is planted, although this requires extra time. Another alternative is to apply enough nutrients for both crops when the small grain is planted. According to recent Illinois experiments, double or triple the annual rates of P_2O_5 and K_2O can be applied every two or three years with yield results as good as those from annual applications.

The northern limit for double cropping soybeans in Illinois has not been defined. When it was tried in Urbana in 1967, yields were low because of limited rainfall. In 1972, however, zero-till, double-cropped soybeans did well at Urbana, as well as at two research centers farther south — Brownstown and Dixon Springs. That year the midsummer rainfall pattern was favorable at all three locations, although it was not sufficient to produce maximum yields. In addition, certain cultural, chemical, and machinery practices enhanced the yields in 1972.

Brownstown results

Six soybean varieties were planted in wheat stubble on July 6-7, 1972, with zero tillage. Wheat yield was 70 bushels an acre. Various combinations of herbicides were applied pre-emergence (Table 1).

Although the herbicide combinations were experimental, the yields for Amsoy and Wayne in Table 1 indicate the potential for zero-till

Table 1. — Yield of Soybeans Planted in Wheat Stubble, Brownstown, 1972

Herbicide treatment[a]	Amsoy				Wayne				Average	
	20-in. rows		30-in. rows		20-in. rows		30-in. rows			
	Yield[b]	Population	Yield[b]	Population	Yield[b]	Population	Yield[b]	Population	Yield[b]	Population
	bu./A.	(000)	bu./A.	(000)	bu./A.	(000)	bu./A.	(000)	bu./A.	(000)
1	36.1	144.4	31.1	111.5	34.4	188.2	34.6	127.2	34.1	142.8
2	38.8	139.8	30.6	103.2	34.0	188.2	29.5	106.3	33.2	134.4
3	40.8	156.2	30.6	90.2	35.8	180.3	30.6	107.2	34.5	133.5
4	29.8	133.3	30.0	97.6	26.6	166.6	21.5	122.0	27.0	129.9
5	41.2	154.2	33.3	107.2	37.0	181.6	35.2	128.1	36.7	142.8
6	40.7	129.4	27.9	93.7	34.1	185.6	29.1	111.9	33.0	130.2
7	45.5	148.3	42.1	112.8	36.8	167.3	35.4	115.4	40.0	136.0
Aver.	39.0	143.7	32.2	102.3	34.1	179.7	30.8	116.9		

[a] Herbicides were applied pre-emergence with a surfactant (S) of X77 at 8 oz./100 gal. water. Treatments were:

1. 2 lb. 50W Lorox, 2 qt. Lasso, 1 pt. Paraquat + S
2. 2 lb. 50W Lorox, 2 qt. Lasso, 1 pt. Paraquat + S, 8 oz. 2,4-D (4 lb. ai/gal. LV ester)
3. 2 lb. 50W Lorox, 2 qt. Lasso, 1 pt. Paraquat + S, 16 oz. 2,4-D (4 lb. ai/gal. LV ester)
4. Check
5. 1 gal. Amiben, 2 qt. Lasso, 1 pt. Paraquat + S
6. 4 lb. Amilan, 2 qt. Lasso, 1 pt. Paraquat + S
7. 1½ lb. 50W Sencor, 2 qt. Lasso, 1 pt. Paraquat + S

[b] 12-percent moisture.

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soybeans without irrigation when midsummer rainfall is adequate. Comparable yields were obtained in 1970, but after the dry summer of 1971, yields were only 5 to 7 bushels an acre. The increase for 20-inch row spacing over 30-inch spacing shown in Table 1 is typical.

Single rows of four other varieties, spaced 20 inches apart, were grown with the same herbicide treatments listed in Table 1. Yields were: Clark 63, 36.1 bushels per acre; Calland, 41.5; Williams, 37.1; and Bonus, 46.2.

Dixon Springs results

At Dixon Springs, soybeans were planted in wheat and barley stubble on June 27, 1972. Natural rainfall was supplemented with irrigation. The additional water helped to establish the soybeans, activate the herbicides, and produce yields comparable to those from a full-season crop.

As shown in Table 2, 20-inch row spacing was important in producing good yields. The data in this table also illustrate the value of timeliness in combining the small grain: Combining the barley was delayed until the wheat crop was ready, resulting in more weed growth in the barley and lower soybean yields.

Besides the experimental herbicide treatments in Table 2, we combined 2, 4, 12, 16, 20, and 24 ounces per acre of 2,4-D with a basic treatment of Lorox, Lasso, and Paraquat plus a surfactant. The various rates of 2,4-D were not consistent in their influence on yield since populations varied considerably. However, the 20-ounce rate seemed to give the greatest yield increases for both Amsoy and Wayne in 20- or 30-inch rows in either wheat or barley stubble. (The soil type was Grantsburg silt loam.)

Table 2. — Yields of Irrigated Soybeans in Wheat and Barley Stubble, Dixon Springs, 1972

Herbicide treatment[a]	20-in. rows		30-in. rows	
	Wheat	Barley	Wheat	Barley
	Amsoy yields, bu./A.[b]			
1	46.9	40.5	38.2	31.3
2	47.7	28.8	38.5	37.7
3	56.3	46.5	36.5	33.0
	Wayne yields, bu./A.[b]			
1	38.7	38.5	39.7	29.6
2	45.1	40.2	37.8	34.1
3	46.1	41.2	29.0	26.0

[a] Herbicides were applied pre-emergence in 67 gal. water. Ten treatments were made; results are given for these three:
1. 2 lb. 50W Lorox, 2 qt. Lasso, 1 qt. Paraquat plus Surfactant
2. Treatment No. 1 plus 8 oz. 2,4-D (4 lb./gal. L.V. ester)
3. 2 qt. Lasso, 2 lb. 50W Lorox, 8 oz. 2,4-D

[b] 12-percent moisture.

Table 3. — Yields of Amsoy in Barley Stubble, 19 Herbicide Treatments, 30-inch Rows, Dixon Springs, 1972[a]

Herbicide treatment[b]	Yield[c]	Population
	bu./A.	(000)
1. 2 qt. Mono 2139, 2 qt. Lasso, 2 lb. 50W Lorox	25.7	215.2
2. 5 qt. Dynap, 2 qt. Lasso, 1 qt. Paraquat + S	22.2	236.1
3. 2 lb. 50W Lorox, 2 qt. Lasso, 1 qt. Paraquat + S	21.7	260.5
4. 1 gal. Preforan, 1 qt. Paraquat + S	20.2	274.4
5. 4 lb. 50W Moloran, 1 qt. Paraquat + S	24.2	250.0
6. 2 lb. 50W Lorox, 1½ qt. Lasso, 1 qt. Paraquat + S, 2 oz. 2,4-D	23.3	279.7
7. 2 lb. 50W Lorox, 1½ qt. Lasso, 1 qt. Paraquat + S, 4 oz. 2,4-D	19.6	289.2
8. 2 lb. 50W Lorox, 1½ qt. Lasso, 1 qt. Paraquat + S, 8 oz. 2,4-D	27.0	227.4
9. 2 lb. 50W Lorox, 1½ qt. Lasso, 1 qt. Paraquat + S, 16 oz. 2,4-D	23.8	267.5
10. 1¼ lb. 80W Bladex, 1 qt. Paraquat + S	24.1	279.7
11. 1¼ lb. 80W Simazine, 1 qt. Paraquat + S	27.3	207.3
12. 2 lb. 50W Sencor, 2 qt. Lasso, 1 qt. Paraquat + S	32.0	222.2
13. 1½ lb. 50W Sencor, 2 qt. Lasso, 1 qt. Paraquat + S	25.3	273.6
14. 1½ lb. 50W Sencor, 2 qt. Lasso	21.5	249.2
15. 2½ lb. 50W Bladex, 1 qt. Paraquat + S	20.3	243.1
16. Check	5.8	217.8
17. 2 lb. 80W Bladex-Planavin, 1 qt. Paraquat + S	26.4	246.6
18. 2 lb. 50W Lorox, 1½ qt. Lasso, 1 qt. Paraquat + S	27.7	235.2
19. 3 qt. Mono 2139, 2 qt. Lasso, 2 lb. 50W Lorox	26.9	251.8

[a] Plots irrigated with 1 in. water July 10.
[b] Treatments applied in 67 gal. water at planting.
[c] 12-percent moisture.

Table 3 shows results of 19 experimental treatments on soybeans planted in 30-inch rows in barley stubble. The plots were irrigated with 1 inch of water on July 10. The barley was short and the stand was reduced by yellow dwarf disease; as a result, weeds were abundant when the soybeans were planted. This head start for the weeds, plus the 30-inch row spacing, made weed control particularly difficult. Several combinations in Table 3 appear promising for use in double-cropped soybeans.

Urbana results

Soybeans were planted in wheat stubble with a zero-till planter on July 6, 1972. The wheat had yielded more than 80 bushels an acre. Some of the plots were irrigated with 3 inches of water on July 10 and another 2 inches on July 24.

Rainfall in Urbana was considerably below normal during the early summer, but was above average in August and September, with 6 and 8 inches, respectively. Relatively high yields were therefore obtained on the nonirrigated plots (Table 4).

Both with and without irrigation, soybeans planted in 20-inch rows consistently yielded 6 to 8 bushels more than those in 30-inch rows. The varietal response and population differences need further study, but are somewhat typical of the results at Dixon Springs and Brownstown.

Table 4. — Yield of Soybeans Planted in Wheat Stubble, Urbana, 1972

Plants per ft. at harvest	Irrigated		Nonirrigated	
	20-in. rows	30-in. rows	20-in. rows	30-in. rows
	Yields of Beeson, bu./A.[a]			
6	39.3	28.6	29.6	21.7
9	36.3	29.5	34.7	23.9
12	39.3	31.5	35.3	23.4
15	37.9	31.8	36.4	24.8
Aver.	38.2	30.4	36.4	24.8
	Yields of Amsoy 71, bu./A.[a]			
6	34.7	26.0	25.5	18.9
9	38.8	32.8	27.2	21.5
12	39.2	29.2	28.5	20.8
15	39.6	29.2	28.5	20.8
Aver.	38.1	30.0	26.7	20.8
	Yields of Hark, bu./A.[a]			
6	32.8	19.0	21.3	15.5
9	34.6	28.8	21.9	16.9
12	38.2	26.8	27.6	18.7
15	37.7	26.6	27.6	18.7
Aver.	35.8	25.3	23.7	17.0

[a] 13-percent moisture.

Does Feeding Antibacterial Drugs Cause Drug Resistance in Bacteria?

D. SIEGEL and W. G. HUBER

ALMOST every animal that goes to market these days has been fed a ration containing antibiotics or sulphonamides for a good part of its life. Livestock and poultry producers add these antibacterial drugs at subtherapeutic levels (that is, levels below those used to treat disease) in the hope of increasing daily gain and feed efficiency. According to government statistics, over 50 percent of the antibacterial drugs produced annually in the United States are used for agricultural purposes, primarily as feed additives.

The widespread use of antibacterial drugs as subtherapeutic feed supplements raises two important questions: Has this practice led to the emergence of drug-resistant bacteria which directly cause disease in man and domestic animals? Has it caused the resident bacteria in farm animals to become drug-resistant and to act as a reservoir of drug resistance for the bacteria in man?

Answers to these questions are being sought in the College of Veterinary Medicine. The present article reports some of our findings about drug resistance in animals.. Studies of humans will be reported in a later issue of Illinois Research.

Nature of drug resistance

Different bacteria may be resistant in varying degrees to a particular antibacterial drug. However, for this study, we defined drug resistance as the ability of an organism to withstand the highest feasible concentration of the drug that can be attained in the blood of man or animal. As defined, resistance of a disease-producing organism to a particular drug will completely negate the desirable therapeutic effects of the drug when used to combat disease.

The entire problem has been complicated and made potentially more serious by a phenomenon known as infectious multiple drug resistance, which exists in gram negative enteric organisms. (These are certain types of bacteria found in the gastrointestinal tracts of man and animals.)

Infectious multiple drug resistance is the rapid transfer of the ability to withstand therapeutic levels of more than one antibacterial drug from a resistant bacterium (a donor) to an initially sensitive bacterium (a recipient). The word "infectious" indicates that the multiple drug resistance is transferred much faster than bacteria can grow. Obviously, this phenomenon creates a much more efficient means of bacterial defense against the therapeutic effects of antibacterial drugs than does classical genetic mutation resulting in a bacterium's resistance to a single drug.

The agent responsible for infectious drug resistance has been designated the R factor. It belongs to a class of genetic elements known as bacterial plasmids. The R factor exists autonomously in the cytoplasm of the bacterium as a small circular string of genes. It replicates independently of the bacterial chromosome.

Within an R factor is a series of genes which give it a unique ability: It can transfer itself, by bacterial conjugation, from one cell to another (from donor to recipient), leaving copies of itself in both. Other separate genes of the R factor are responsible for resistance to different antibacterial drugs. Thus, transfer of the R factor to a drug-sensitive recipient changes that recipient into a mutiply drug-resistant organism. This organism, in turn, may pass on multiple drug resistance to other sensitive recipients. In this manner, a gram negative enteric bacterial flora that is predominately sensitive to drugs can quickly become predominately resistant.

Fecal flora investigated

The first question that one must answer is: Does the use of antibacterial drugs in feed result in a gram negative enteric flora composed primarily of organisms resistant to these drugs? It has been established that essentially all animals raised on feeds containing antibacterial drugs excrete drug-resistant organisms in their feces. Furthermore, high proportions of pathogenic and nonpathogenic *Escherichia coli* and *Salmonella* isolated from animals receiving antibacterial drugs have been reported to be multiply resistant to a wide range of such drugs.

It is likely that all members of the gram negative enteric bacterial flora will contribute to a reservoir of resistance. We therefore investigated the relative proportions of resistant organisms in the enteric flora of individual fecal samples from groups of animals with different exposures to antibacterial drugs.

Dilutions of a suspension of fecal material were spread on the surface of (MacConkey) agar petri plates. From the number of colonies growing out on these plates, we determined the total number of gram negative enteric organisms in the fecal sample. Next, we determined the number of organisms that were resistant to three antibiotic drugs: oxytetracycline, dihydrostreptomycin,

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Distribution of Fecal Samples From Illinois Farm Animals and Montana Range Cattle According to Proportions of Gram Negative Enteric Organisms Resistant to Three Antibacterial Drugs

Drug and class of livestock	Proportions of resistant organisms[a]				
	10/10 to 1/10	1/10 to 1/100	1/100 to 1/1,000	1/1,000 to 1/10,000	Less than 1/10,000
	percentage of samples				
Oxytetracycline					
Ill. swine	96	3	0	1	0
Ill. cattle	62	15	8	8	8
Ill. poultry	95	0	0	0	5
Range cattle	0	0	1	0	99
Dihydrostreptomycin					
Ill. swine	98	1	1	0	0
Ill. cattle	62	8	15	8	8
Ill. poultry	82	12	6	0	0
Range cattle	0	0	3	3	94
Ampicillin					
Ill. swine	83	12	2	0	3
Ill. cattle	31	15	23	15	15
Ill. poultry	41	6	18	12	23
Range cattle	0	1	6	3	90

[a] Figures indicate only the proportions that were resistant and do not suggest the numbers of organisms tested for resistance. More than 100,000 organisms were tested from each sample. 10/10 means that all organisms tested were resistant; 1/10, one out of every 10 organisms tested was resistant, etc.

and ampicillin. In doing this, we again used agar petri plates, this time adding enough of a particular antibiotic to assure that only resistant organisms would grow. To determine the proportion of resistant organisms in the sample, we divided the number of resistant organisms by the total number of organisms.

Farm and range animals compared

The proportions of organisms resistant to the three drugs were determined for 391 individual swine fecal specimens collected from 30 Illinois farms; for 13 fecal specimens from beef cattle on 4 farms; and for 17 composite fecal specimens from poultry on 9 farms. All animals had been raised on feeds continuously supplemented with antibacterial drugs.

To assure that the proportions of resistant organisms obtained from Illinois farm animals could be directly related to the feeding of antibacterial drugs and not to some other condition, 100 fecal samples from Montana range cattle were also analyzed. These animals had little contact with man and lived in an environment with minimal or no exposure to antibacterial drugs.

As is shown in the preceding table, large percentages of samples from Illinois farm animals contain high proportions of drug-resistant gram negative enteric organisms. Resistance to oxytetracycline and dihydrostreptomycin, which are frequently fed, was especially high. Organisms resistant to ampicillin were also numerous in a significant number of samples. Although ampicillin is not used in feeds, it does share some cross resistance with penicillin.

Interestingly, where gram negative enteric pathogens such as *E. coli* and *Salmonella* appear to cause the most serious and prevalent disease problems — that is, in swine — the levels of resistant organisms are also the highest. The comparatively high concentrations of resistant organisms in swine samples is no doubt directly related to the fact that antibiotics are used more extensively for swine than for other livestock.

Results obtained with Montana range cattle offer a striking contrast to the results obtained with Illinois farm animals. The great majority of samples from range cattle contained fewer than 1 out of 10,000 organisms resistant to any of the antibiotics tested. Actually, in most of the samples resistant organisms could not be detected at all because of the limited number of bacteria that could be plated. Therefore, the actual proportions of resistant organisms in these samples could be considerably less than 1 out of 10,000.

Should antibacterial drugs be fed?

These results, plus the results of other laboratories, strongly support the contention that the agricultural uses of antibacterial drugs cause substantial levels of drug resistance in the microflora of farm animals. This condition may have practical consequences not only to the farmer, but also to the consumer.

Under normal circumstances, the great majority of the organisms in the gastrointestinal tracts of man and animals do not cause disease. Therefore, their resistance to antibacterial drugs would not normally be considered of any consequence.

It has been well established, however, that most and possibly all antibacterial drug resistance in gram negative enteric bacteria can be transferred from one organism to another; that is, most and possibly all resistance is mediated by R factors. In effect, the organisms comprising the resident flora may thus serve as a reservoir for resistance which can be transmitted to drug-sensitive pathogens, making them multiply drug-resistant.

The likelihood of a drug-sensitive organism becoming resistant, and the speed with which it does so, may be related to the frequency of its contacts with resistant organisms containing R factors. The contacts are more likely to be frequent in the resident flora of animals that have been fed antibacterial drugs than of animals that have had minimal or no exposure to these drugs. This has been evidenced by the work reported here as well as by that done elsewhere.

The possible advantages gained by the continuous use of antibacterial drugs at subtherapeutic levels for animal production purposes — not for the treatment of disease — may thus be outweighed by the creation of drug resistance in resident bacteria and pathogenic bacteria.

Recycled Swine Waste as Feed

B. G. HARMON and D. L. DAY

USING ANIMAL WASTES to produce feedstuffs offers two obvious advantages: the elimination or minimization of pollution and a new source of nutrients. Pollution abatement is bound to come about; the challenge is to design a system of pollution control that also generates an end product of value.

Since 1963 the University of Illinois has been conducting research on managing swine waste by means of aerobic microbial action in an oxidation ditch beneath slotted floors (see illustration). This process entails not only installation costs but also operating costs, as a paddle wheel or other means of agitation is needed to move the waste around a raceway and aerate the tank. At least part of these costs could be recovered by converting the waste into a usable feed.

Numerous procedures have been reported for enhancing or preparing animal wastes for feeding. And animal response to these materials in diets has been as varied as the procedures.

Amino acids emphasized

In our studies we have planned to take advantage of the fermentation common to oxidation ditches. We consider the waste as a high-nitrogen crude biomass from which a single-cell protein can be formed.

Most of our attention has been given to the amino acid content of the fermentation mass, partly because amino acids are the most obvious constituent of single cells. Moreover, they are the costliest of the nutrients needed to supplement corn and so would be the most valuable products. Oxidation ditch mixed liquor (ODML) also contains vitamins and minerals, but these have less economic value than the amino acids.

As the ODML undergoes fermentation, aerobic microbiota enhance its amino acid content (Table 1). The environment of the oxidation ditch tends to conserve nitrogen. This is indicated both by the values in Table 1 and by nitrogen analyses of samples from the ditch. These show that the ditch contents are about 50 percent crude protein.

Table 1. — Selected Amino Acid Values of Fresh Swine Waste and ODML

Amino acid	ODML	Fresh waste
	percent of dry matter	
Lysine	1.42	0.60
Arginine	1.28	0.44
Threonine	1.96	0.53
Isoleucine	1.49	0.52

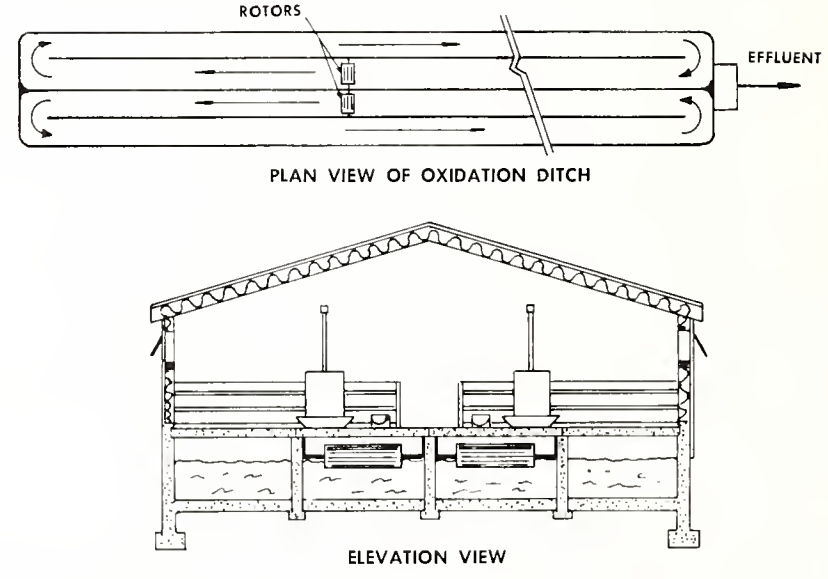
According to the evidence in Table 2, the crude protein and amino acids are concentrated in the small particles in the ditch. Urea that would pass through the smallest screen and appear as protein is found in trace amounts, if at all, in a functioning oxidation ditch. These data strongly support our previous statement that nitrogen sources in animal wastes are quickly used by microbiota in building amino acids.

Solid material tried

In our early attempts to harvest material from the ditch, we drew off the fluids, then oven-dried the remaining solids. We thus lost the valuable single-cell protein fraction, which drained off with the fluids. But even without this fraction, the oven-dried residue proved nutritious for rats on a corn-soybean meal diet. When half the soybean meal was replaced with enough residue to provide the equivalent amount of protein, rate and efficiency of gain equaled those for the control diet (Table 3).

Studies with liquid ODML

A properly functioning oxidation ditch will have 4 percent dry matter or less. To remove all the water without losing the more valuable nutrients is costly. A feeding scheme was therefore established to use the ODML in liquid form. ODML (with an average of 3 percent dry matter) was pumped into a holding tank, where it was further aerated and



Totally slotted swine-confinement building with an oxidation ditch beneath the self-cleaning slotted floors.

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Table 2. — Analysis of Sieved Particles of ODML

Screen mesh	Size opening	Protein	Lysine	Threonine	Isoleucine
	in.		percent of dry matter		
20	.0328	8.4	0.38	0.98	0.81
50	.0117	11.1	0.92	1.57	1.13
100	.0058	20.0	1.36	2.01	1.66
>200[a]	.0029	75.6	3.08	2.44	2.20

[a] Material passing through that screen.

Table 3. — Effects of Using Oxidation Ditch Residue in Corn-Soybean Meal Diets for Weanling Rats

	Diet			
	A	B	C	D
Corn vitamins, minerals, %	50.0	50.0	50.0	50.0
Corn starch, %	22.8	11.9	1.0	...
Soybean meal, %	27.2	13.6	...	...
Oxidation ditch residue, %	...	24.5	49.0	49.0
Lysine HCl, %	...	...	...	1.0
Av. daily gain, gm.	4.8	5.3	0.9	0.3
Gain/feed	0.37	0.30	0.06	0.01

mixed between feedings so that it would have adequate biological enhancement by the aerobic microbiota when fed. Nutrient composition of the ODML is given in Table 4.

For one study, either water or ODML was mixed with a 12 percent protein corn-soybean meal diet in a ratio of 2 parts liquid to 1 part dry feed at the time of feeding. All swine had access to automatic waterers.

In five replications, a total of 76 finishing swine were fed twice daily in open troughs. Rate and efficiency of gain were significantly higher for pigs receiving ODML than for those receiving water (Table 5). ODML increased protein intake by about 3 percent and lysine by about 0.1 percent.

Another study involved 40 finishing swine in a short-term trial with two replications. The pigs in half the pens had access to ODML at all times as their only source of water. Control pigs had continuous access to tap water. A corn-soybean meal diet (12 percent protein) was available in self-feeders in each pen.

The ODML was pumped from the ditch into shallow sloping troughs for 20 seconds of every 10 minutes. The initial flow flushed out any liquid remaining in the trough, while the flow as the pump stopped refilled the trough.

Feed intake, rate of gain, and efficiency of gain were not significantly different for pigs receiving ODML than for those receiving water (Table 6). However, what difference there was consistently favored pigs receiving ODML. The swine were able to get all their liquid from the enriched medium without sacrificing performance. In this study, even with only half of the pigs consuming enriched liquid from the ditch, no effluent was discharged from the building. Actually make-up water was added to the ditch to maintain the original volume.

In a subsequent test, some trial pigs died, apparently from nitrate poisoning. This problem is being further studied.

Table 4. — Nutrient Content of ODML (Percent of Dry Matter)

Nutrient	Pct.	Nutrient	Pct.	Nutrient	Pct.
Phenylalanine	1.48	Aspartic	3.73	Calcium	3.33
Lysine	1.42	Serine	2.55	Phosphorus	3.83
Histidine	0.47	Glutamic	5.06	Magnesium	1.49
Arginine	1.28	Praline	1.29	Sodium	2.75
Threonine	1.96	Glycine	2.29	Potassium	4.14
Valine	2.06	Alanine	2.83	Iron	0.5507
Methionine	0.77	Tyrosine	1.17	Copper	0.0071
Isoleucine	1.49	Tryptophan	0.28	Zinc	0.1148
Leucine	2.79				

Table 5. — Performance of Finishing Swine Receiving Water or ODML in a Corn-Soybean Meal Diet

	Water	ODML
Aver. daily gain, kg.		
Replication 1	.49	.51
" 2	.46	.55
" 3	.49	.57
" 4	.64	.65
" 5	.50	.53
Average	.52	.56
Goin/feed		
Replication 1	.218	.232
" 2	.213	.249
" 3	.275	.276
" 4	.283	.302
" 5	.256	.270
Average	.249	.266

Table 6. — Performance of Finishing Swine on a Corn-Soybean Meal Diet Plus Water or ODML as Only Liquid

	Tap water	ODML
Aver. daily gain, kg.		
Replication 1	.61	.63
" 2	.66	.70
Average	.64	.67
Goin/feed		
Replication 1	.303	.308
" 2	.296	.297
Average	.300	.302

Meat is satisfactory

Comparisons of pork chops and roasts from hogs fed ODML and from control hogs showed that taste and odor were not influenced by feeding the aerobically sustained product. Observations of specific microbial species have been very limited, but random samplings have revealed no salmonella.

About 300 hogs have been fed in ODML studies over the past three years. Representative samples of all the hogs have been slaughtered and inspected for liver or lymphatic tissue changes. No changes attributable to feeding the single-cell product have been found in the slaughtered animals. All the carcasses have passed meat inspection.

We are hopeful that the end results of our studies will be an effective use for a product previously described as a waste.

Soils in Plant Containers:

Soil Amendment, Air, And Water Relationships

L. ARTHUR SPOMER

Probably the most important nutrient required for plant growth and survival is water. It constitutes 80 to 95 percent of the weight of actively growing plant tissue, and plants often consume hundreds of times this amount during growth. Directly or indirectly, water affects every growth process throughout the plant's life.

Plants absorb most of their water needs directly from the soil. The availability of soil water thus can strongly influence plant growth and survival. Plants grown in containers are much more likely to suffer from a lack of available soil water than are plants grown in ground beds.

Containers limit water supply

Nearly all ornamental plants are propagated as seedlings or cuttings in some kind of container. House plants remain in containers their entire life. Landscape ornamentals remain in their original containers until they are large enough to be transplanted. An increasing number of them are transplanted into outdoor landscape containers or planters rather than into ground beds.

Identical principles apply to plant culture in both containers and ground beds. However, the typically small volume and shallow depth of a container result in a soil water reservoir too small to maintain growth for more than a short period. At the same time the soil is often too wet and the aeration too poor for the plant to readily absorb even this inadequate water supply.

The dilemma of both too little and too much soil water in containers can be minimized by a combination of good container design, soil mixture, and irrigation management. This article briefly reports current University of Illinois research on container soils, which is one phase of a broader study on container-soil-plant-water relations.

Characteristics of soil containers

Almost any container filled with soil can be used for growing plants. Pots, planters, cans, and benches are most commonly used for ornamental plants. Although the size and shape of these different containers vary tremendously, all (a) isolate the soil mass, (b) have an open top surface where the plant shoot is exposed, (c) have an open drainage hole at the bottom, (d) are relatively shallow, and (e) are relatively small.

Container soils

All soils consist of a matrix of minute solid particles packed into a rigid, sponge-like mass (Fig. 1). Open spaces or pores form irregular tunnels that permeate the matrix. Both water and air are stored in and move through the pore network. The pores in a dry soil are filled with air. When a dry soil is irrigated, water displaces the air and the soil becomes saturated. After irrigation ceases, some of the water drains downward out of the pores and is replaced by new air. The soil remains wet but usually not saturated.

After a uniform ground bed drains, water is distributed relatively uniformly throughout its wetted depth (Fig. 1). When a container soil drains, however, a perched water table develops at its bottom — that is, the bottom is saturated — and water content decreases with height above this water table (Fig. 1).

The actual distribution of water in a container soil is determined by the soil's depth and porosity. A shallow soil has a higher average water content that a deep soil, and a soil with predominantly small pores tends to retain more water in the upper layers than one with predominantly large pores (Fig. 2). The relationship between water retention and depth in a soil is identical to its soil moisture

L. Arthur Spomer is Assistant Professor of Plant Physiology, Department of Horticulture. The research reported in this article was partly supported by Coop-Aid Study Contract 23-00,308, USDA Forest Service Forest Product Marketing Laboratory, Princeton, W.Va.

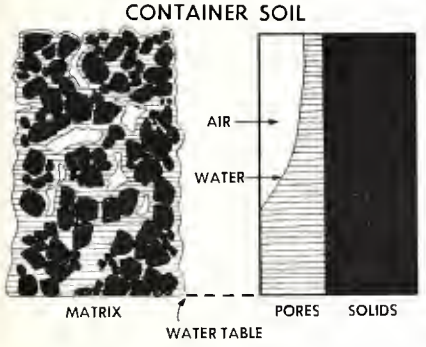
characteristic (water content vs. matric potential).

Most soil containers are less than 20 inches deep and many are even less than 4 inches deep. Almost any natural soil except a very coarse-textured soil in these containers will be too wet and the plants will suffer from poor aeration. The opposite problem occurs in a coarse-textured soil — it will be sufficiently aerated, but it may not retain enough water. The ideal container soil is a compromise between these two extremes, or a soil that has enough small pores to provide adequate water storage and enough large pores to ensure adequate aeration.

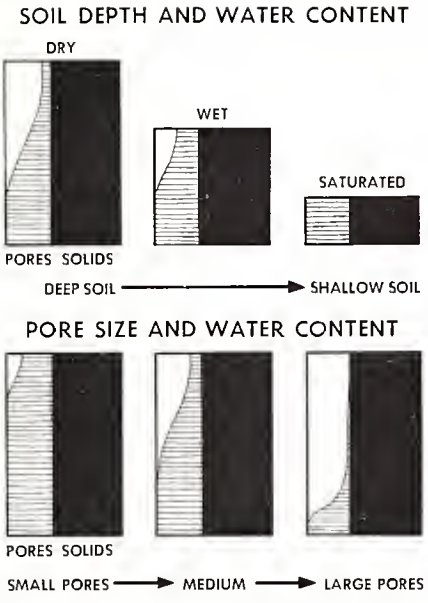
In practice this ideal is approximated by mixing a coarse-textured amendment (such as sand, perlite, calcined clay, vermiculite, peat, sawdust, or bark) with soil or another amendment (soilless mix). The shallower the container, the coarser the amendment required to provide sufficient aeration (Fig. 2).

Most of the commonly recommended mixtures of soil and amendment have been formulated with little or no knowledge of the components' physical properties. Likewise, the concept of "critical proportion" has been largely ignored.

The critical proportion of amendment to soil is determined primarily by the amendment's natural packing structure and total porosity. Assume, for example, that 30 percent of the total volume of a particular amendment is pore space. Additions of this amendment to the soil will actually decrease aeration and water-holding capacity until the amendment makes up 70 percent of the mixture (Fig. 3). Aeration and water-holding capacity are improved only when the proportion of amendment exceeds 70 percent.



At left, soil matrix in a container 18 inches deep and in a ground bed to about the same depth. Irregular black shapes represent soil particles; white shapes, air; horizontal lines, water. Note that the ground bed has more air at lower depths than does the container. The two charts at right represent the proportions of air and water in the soils, assuming that all soil particles could be compressed to one side. They also indicate the depths to which air would be found. (Fig. 1)

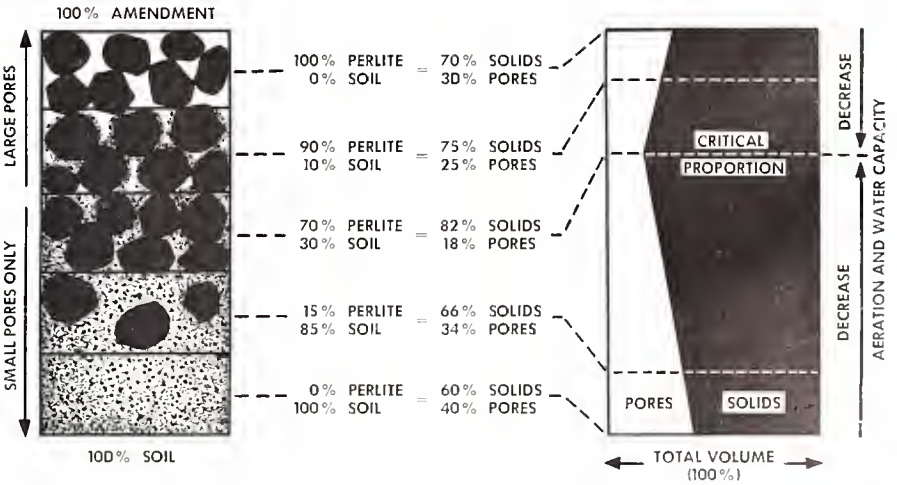


Top, container soil depth affects average water content; a shallow soil is wetter than a deeper one. Bottom, average pore size can also affect container soil water content; a soil with small pores will be wetter than one with larger pores. (Fig. 2)

Tailoring containers and soils

With the wide range of available containers and amendments, it is apparent that soil containers and container soils can be tailored to satisfy the cultural requirements of almost any ornamental plant. Manipulation of the water-holding characteristics of soil mixtures is relatively simple. It requires only a few physical measurements and empirical tests on the mixture and its components.

Our future research in this area will be aimed primarily at determining the specific water and aeration requirements of container-grown plants, so that the proper recommendations can be made for containers and soils.



Starting with 100 percent soil, additions of perlite up to about 70 percent (critical proportion) reduce total pore space without increasing the number of larger pores. Starting with 100 percent perlite, additions of soil up to about 30 percent reduce total pore space by filling in the larger pores. The critical proportion of amendment to soil varies with the kind of amendment and the kind of soil. (Fig. 3)

New Uses Found For Discarded Christmas Trees

POO CHOW

At left, recycled Christmas tree chips before hammermilling; at right, hammermilled particles. (Fig. 1)

Disposing of Christmas trees has become a major problem in areas where burning is not permitted. A city of 100,000, for example, will have to get rid of about 17,000 trees next winter. Some communities are chipping the trees to reduce bulk and hence hauling and dumping costs.

According to a Department of Forestry study, these chipped trees can become an asset rather than a liability. Chips have been made into experimental particleboard that is strong enough for many purposes and that has a very attractive appearance due to the color and texture of needles, bark, and branches.

How board was made

Used Scotch pine Christmas trees were processed through a wood chipper. The chips were further milled with a hammermill, using a ½-inch screen (Fig. 1) and were dried to a moisture content of 8 percent.

Small amounts of urea-resin and wax emulsion were applied by a spray gun to the tumbling particles in a mixer. After blending, the material was formed into mats of the proper weight. The mats were then consolidated into particleboard in a hydraulic hot press. Steel stops were used to control the thickness of the board.

Tests and results

Specimens cut from the boards were tested for physcial and mechanical properties in accordance with the procedures described in Standard ASTM D-1037-72. As shown in the table, the bending strength of the experimental boards was slightly below the commercial standard for interior type particleboard. This was probably due to the fact that needles made up 20 percent of the weight in the board. Needles are not structurally fibrous materials and offer no resistance to bending.

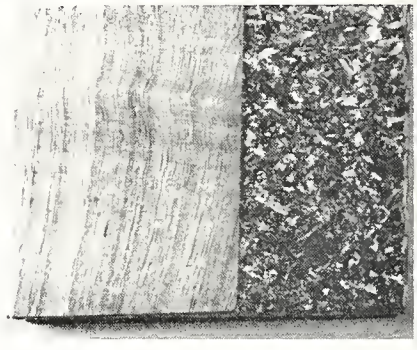
If the boards are to be used in a vertical position, such as for wall paneling, their bending strength would be adequate. However, if they are to be used in a horizontal position to support a heavy load, they should probably be overlaid by wood veneers (Fig. 2). According to internal bond tests, the experimental boards have exceptionally good machinability and gluability.

The dimensional stability of this new product is considered average. After the 24-hour cold-water soaking test, the boards swelled only 10 percent in thickness. None of them disintegrated in water.

Strength Properties of Experimental Boards Compared to Commercial Standards for Particleboard

Property	Experimental boards	Commercial standard	Strength ratio
Density, lb. per cu. ft.	49.5	37-50	...
Modulus of elasticity, psi	230,000	250,000	0.92
Modulus of rupture, psi	960	1,600	0.60
Internal bond, psi	118	70	1.68
Thickness swelling, pct.[a]	10	...[b]	...

[a] After 24-hour soaking.
[b] No minimum standard hos been provided.



Finished panel, with walnut veneer overlying half the surface. (Fig. 2)

Various uses

The surface appearance and strength properties of this new product suggest that it is most suitable for vertically installed interior paneling and for decorative items such as wall plaques. It could also be used for laminates, puzzles, and toys.

As already mentioned, about 17,000 trees are used every year in just one city of 100,000. Assuming an average dry weight of 15 pounds per tree, these trees would provide enough raw material for about 25,000 sheets of ¼-inch board 24 inches wide and 48 inches long. Utilizing Christmas trees in this way will not only solve the disposal problem but will provide board manufacturers with a new source of raw materials.

Poo Chow is Assistant Professor of Wood Science, Department of Forestry.

Particle Size and Bulk Density of Residues From Illinois Hardwoods

POO CHOW

In WESTERN and southern states, where the major wood-processing industries are located, many wood and bark residues go into board, paper, and agricultural products. In Illinois and other midwestern states, however, wood residues are not being extensively utilized although wood-using industries generate large amounts of waste.

Before midwestern wood residues can be used, basic information is needed about their physical properties — especially particle size and bulk density — since they affect costs and methods of handling, processing, and storing the materials.

Unrefined wood and bark residues are usually very irregular in size and shape. To be useful, they must be processed in a refiner. Size distribution of the refined particles helps to determine best use for the material.

Bulk density, or weight per unit of volume, is widely used to measure the quantity of wood and bark residues. Board manufacturers, who need large amounts of wood material, prefer a high bulk density because shipping cost is based on both volume and weight. On the other hand, when residues are to be used in plant potting materials or a packaging material, low bulk density is desirable because of the reduced shipping costs, as well as for other reasons.

Seven types of wood and bark residues from Illinois wood-using industries were collected for a study of bulk density and particle size. The residues were refined in a hammermill with a ½-inch screen.

Bulk densities of both unrefined and refined materials were determined with use of a rectangular plywood box. Four randomly selected samples of each material were measured.

A Cenco-Meinzer sieve shaker and four sizes of Tyler standard sieves were used to ascertain particle-size distribution. Two replicate samples of each material were put through the shaker. Before the screening test, moisture contents were measured with a Cenco moisture balance.

In addition, bulk density and particle size were determined for a commercially milled southern pine furnish for particleboard, and a commercial mulch of Douglas fir bark which had been refined in a hammermill.

After hammermilling, most of the Illinois residues had bulk densities comparable to those for the commercial Douglas fir and southern pine samples (Table 1). Hammermilling increased bulk densities and therefore would affect shipping, handling, and storage costs. However, none of the materials exceeded 20 pounds per cubic foot in bulk density, which is the maximum generally specified for mulching and landscaping materials.

Visual inspection of the hammermilled residues showed that materials retained on mesh numbers 5, 10, and 20 were granular particles; those that passed mesh number 40 were fines. A high percentage of fines was obtained from hammermilled red oak sawdust, cottonwood bark, walnut bark, white oak bark, maple shavings, and commercial Douglas fir bark. Most of the fines from barks were powder-like dust that probably came from the outer portion of the bark tissues.

The presence of fine particles is not necessarily detrimental. When residues are used for agricultural purposes, the smaller particles are said to allow for increased microbial attack, thereby hastening decomposition. The finely textured materials would therefore make good mulch. They could also be utilized as absorbent or bedding for livestock, and as packaging material.

Materials that pass through mesh number 20 can be used in the surface layers of multilayered particleboard. They provide a solid, smooth surface that is excellent for subsequent laminations. Furthermore, some of the fines can be mixed with the coarse core particles to improve internal bond strength and machinability of board edges.

Table 1. — Average Bulk Density of Residue Furnishes

Type of residue	Moisture pct.	Bulk density, lb. per cu. ft.	
		Unrefined	Hammermilled
Maple shavings and sanderdust	5.5	6.2	6.7
Red oak sawdust	5.0	11.7	11.7
Cottonwood bark	5.6	5.6	13.6
Walnut bark	6.5	11.5	16.2
White oak bork	5.5	7.0	18.0
Red oak bark	6.0	15.5	20.0
White oak cooperage waste	6.0	15.1	20.0
Southern pine particles for particleboard	5.6	...	14.6
Douglas fir bark for mulching	6.0	...	17.5

Table 2. — Distribution of Particle Sizes Obtained From Hammermilled Residues

Residue type	Mesh designation[a]			
	−5/+10	−10/+20	−20/+40	−40
	percent of material			
Maple shavings and sanderdust	25.0	15.0	20.0	40.0
Red oak sawdust	26.4	20.5	14.4	38.7
Cottonwood bark	2.1	30.6	33.1	34.2
Walnut bark	6.6	26.4	32.9	34.1
White oak bark	4.4	23.9	39.5	32.2
Red oak bark	24.6	41.6	22.2	11.6
White oak cooperage waste	27.1	39.9	24.2	8.8
Southern pine particles for particlebaard	18.8	47.5	26.3	7.4
Douglas fir bark for mulch	15.0	20.0	24.5	40.5

[a] Tyler standard sieves. The higher a mesh number, the finer the screen. Material passing a given mesh is indicated by a minus sign; material retained on a mesh, by a plus sign. For example, a −5/+10 designates material that passed through mesh number 5 but remained on mesh number 10.

Professor Chow is identified on page 18.

FARM BUSINESS TRENDS

Prices of farm products have been fluctuating widely in recent years (see charts below) and will likely continue to do so for several more years. This will make for large variations in farm income.

There are several reasons for the big price changes: (1) Government price stabilization programs have become less effective. (2) Farmers have become more specialized. (3) Consumers have become more affluent. (4) World demand for food is increasing faster than supply.

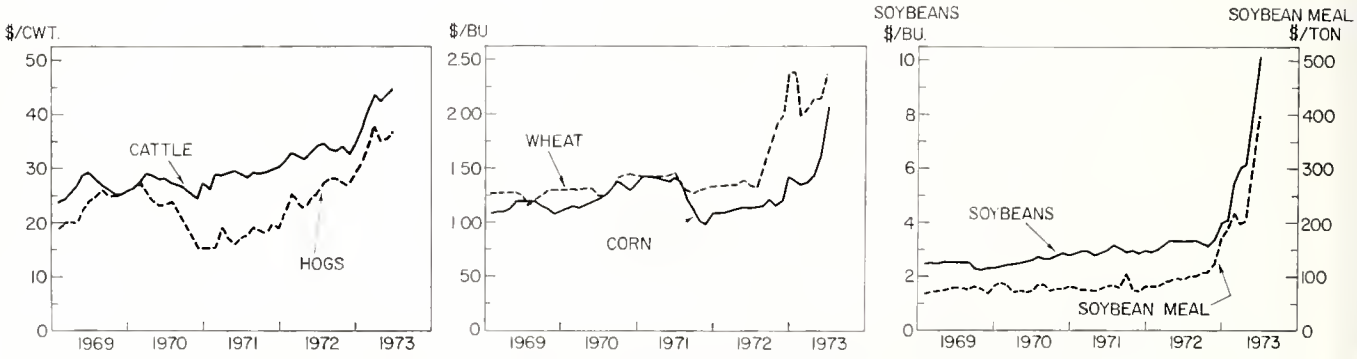
During the 1950's and 1960's, the government carried out large price-stabilization operations. When production was excessive, the USDA took the surplus. When production fell short of needs, the USDA sold some of its reserves. These actions greatly restricted price movements. In recent years large exports have depleted government stocks of grain, and prices have risen far above practical support levels. Consequently, prices can no longer be effectively stabilized by the usual methods.

In earlier times, typical farmers grew three or more crops — perhaps corn, soybeans, oats, hay, and pasture — and also produced hogs, cattle, milk, chickens, and eggs. With so many enterprises, they could make numerous adjustments to changing weather and market conditions. Now most farmers are highly specialized, often producing only two or three products. Some produce only one, such as eggs or broilers. They do not even grow the feed that they need for their birds but must buy it, virtually regardless of cost. Many dairymen, cattle feeders, and hog producers must also buy their feed. Conversely, farmers without livestock must sell their crops.

With rising incomes, consumers have become more consistent buyers of meats and other food products. Some complain about high prices, but most continue to buy the usual amounts. The result is that a specific change in the supply of meat brings a larger change in the price of livestock than formerly. The same rule applies to chickens and eggs.

World food production increased markedly in recent years, but demand increased even more. U.S. farmers gained from increasing exports, but prices of wheat, feed grains, and soybeans now are strongly influenced by developments in foreign lands.

Farmers generally benefit from strong upswings in prices of farm products. Downswings, however, make problems for many farm families — and often for the public as well. — *L. H. Simerl, Professor of Agricultural Economics*



Prices received by U.S. farmers for cattle, hogs, wheat, corn, and soybeans; and prices at Decatur for soybean meal.

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ILLINOIS RESEARCH

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IN THIS ISSU

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timeliness costs (page 17

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 15, Number 4

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CONTENTS

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DR. JONES NEW ASSOCIATE DIRECTOR

I AM HAPPY to announce the appointment of Benjamin A. Jones, Jr., as Associate Director of the Experiment Station. He succeeds Raymond J. Miller, who left in August to become Director of the Idaho Agricultural Experiment Station.

A native of central Illinois, Dr. Jones attended the University of Illinois, receiving his B.S. degree in agricultural engineering in 1949; his M.S. degree in 1950; and his Ph.D. degree in civil engineering in 1954. He has been on the staff of the Department of Agricultural Engineering since 1952.

During his years at the University, Dr. Jones has made many contributions both to agricultural engineering and to the University as a whole. In research, drainage has been his chief interest, but he has also conducted studies on agricultural hydrology, sprinkler irrigation, and soil erosion. Last summer he was named a Fellow of the American Society of Agricultural Engineers, in recognition of his research contributions to highway and agricultural drainage.

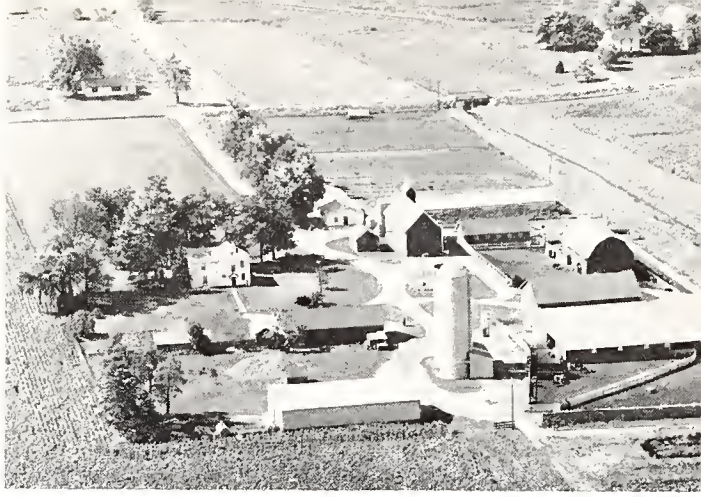
He is the co-author of a widely used textbook on agricultural mechanization; has taught various undergraduate and graduate courses; and has directed thesis research in soil and water engineering. In addition, he has served on a number of committees related to teaching in both the College of Agriculture and the College of Engineering. Although never actually on the Cooperative Extension staff, he has been active in Extension work.

Dr. Jones has represented the Illinois Agricultural Experiment Station on five regional research committees, having served as chairman of three of these. He has also been a member of three all-University Committees: the Technical Advisory Committee of the Water Resources Center; the Drainage and Flood Control Committee of the University Council on Community Development; and the University Committee on Admissions.

Dr. Jones' new position as Associate Director will mean a further broadening of his responsibilities. He will be concerned with the entire research program of the Experiment Station, his special duties being fiscal management and the implementation of research projects. He will also be administrative coordinator for the Council on Human Nutrition, which was recently established by Dean O. G. Bentley to facilitate interdisciplinary research on the many aspects of human food and nutrition. — *G. W. Salisbury*

Illinois Agriculture:

The Changing Scene



ANDREW J. SOFRANKO

ONE DOESN'T have to study the U.S. *Census of Agriculture* to know that dramatic changes have occurred in American agriculture during the last 20 years. Farms have become larger and more productive; specialization has increased; general farming has declined; and the number of farmers has decreased.

What one does get from the agricultural censuses is specific information on the rate and scope of changes. Comparing data from the last two censuses — for 1964 and 1969 — we can identify some of the changes occurring in Illinois agriculture. And by studying the data for the regions designated by the Illinois Crop Reporting Service we can determine how the different parts of the state vary from the average.

State changes

Total acres of farmland in Illinois remained fairly constant between 1964 and 1969 (Table 1). However, number of farms declined by almost 7 percent, with an average of 1,852 farms going out of business every year. As a result, average farm size increased 7.3 percent.

The loss of farms was concentrated in the 50-499 acre category. In the Census of Agriculture, this category is subdivided into 50-99, 100-199, and 200-499 acre groups. All three groups showed losses between 1964 and 1969. As would be expected, the number of farms 500 acres and over increased — the increase amounting to 45 percent. Surprisingly, the number of farms under 50 acres also increased, though only slightly (3.2 percent). This is a sharp reversal of the trend from 1959 to 1964, when there was a 20 percent reduction in the number of small farms.

Capital investments per farm increased by 46.5 percent, reflecting increases in farm size and the requirements of new technologies. The increase from 1959 to 1969 was 85 percent.

The number of farms operated by full owners increased 2.87 percent. Decreases occurred in the numbers of farms operated by tenants, by part-owners, and by farmers living on the farm they operated.

The most striking observation about the age of Illinois farmers is the 11.7 percent increase in the number of farmers under 25. And the average age of all Illinois farmers was slightly lower in 1969 than in 1964. Although this difference is quite small, it is still a reversal of the trend from previous censuses.

There was an 18 percent increase in number of farmers reporting off-farm work. By 1969 more than half of all Illinois farmers were working off the farm. In 1964, 40 percent were doing so. Of those reporting off-farm work in 1969, almost half reported 200 or more days.

Turning to economic class of farms, we see that the biggest change occurred in Class I farms, which increased by almost 67 percent. The number of part-time farms also increased substantially. There is no way of determining from the census data how much of this latter increase was contributed by former full-time farmers, and how much by former non-farmers moving out to the countryside. The sharpest loss was in number of Class VI farms, which are essentially small-scale, subsistence-type operations.

Regional figures show variations

State averages, of course, do not indicate the changes going on in the various parts of the state. To see some of these changes, we can compare the nine regions designated by the Illinois Crop Reporting Service. These regions are shown on the map on page 4, together with the predominant types of farming in each.

Just as the state averages mask regional variations, the regional averages obscure variations — sometimes quite substantial — within a region. In the southeast region, for example, average farm size in 1969 ranged from 163.7 acres in Massac County to 368.2 in Gallatin County; and the percentage change in average farm size from 1964 to 1969 varied from 1.5 percent in Massac County to 19.0 percent in Franklin County. The average change for the region was 10.1 percent (Table 2).

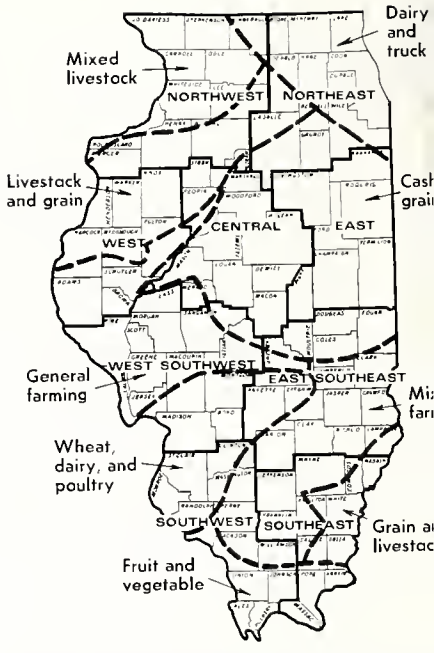
In the east region, which is more homogeneous in type of farming, the intra-regional variations are less pronounced. Average farm size in 1969 ranged from 261 acres (Kankakee County) to 313 (Piatt), and percent change in average farm size ranged from 2.5 percent in Piatt County to 9.4 percent in Ford County. (More information on changes and differences within regions may be obtained by writing to the author.)

Andrew J. Sofranko is Assistant Professor of Agricultural Economics. This research report was prepared as a contribution to the North Central Regian Cooperative Project NC-97.

Table 1. — Selected Characteristics and Changes in Illinois Farming

Characteristic	1969	1964	Pct. change
No. of farms	123,565	132,825	— 6.97
Land in farms, acres	29,913,190	29,957,500	— .001
Av. farm size, acres	242	225.5	7.3
No. of farms by acres harvested			
1-49 acres	26,247	25,426	3.22
50-499 acres	80,667	94,275	—14.43
500 acres and over	5,040	3,473	45.11
Value of land and buildings			
Av. per farm	$118,507	$80,894	46.49
Av. per acre	$ 489.53	$ 356.94	37.14
Tenure status			
No. of farms operated by full owners	56,164	54,592	2.87
No. of farms operated by part owners	36,416	37,446	— 2.75
No. of farms operated by tenants	30,985	40,314	—23.14
No. of operators residing on farm operated	94,580	118,405	—20.12
No. of farm operators by age group			
Under 25 yr.	3,018	2,701	11.7
25-34 yr.	14,498	14,925	— 2.86
35-44 yr.	25,137	29,447	—14.63
45-54 yr.	34,054	35,896	— 5.12
55-64 yr.	30,744	30,284	1.51
65 yr. and over	16,114	19,569	—17.65
Av. age	49.7	50.1	— .79
No. of operators reporting days work off farm	64,059	54,217	18.15
No. of farms by economic class			
Class I (sales of $40,000 and over)	16,630	9,966	66.86
Class II (sales of $20,000-$39,999)	25,859	25,449	1.61
Class III (sales of $10,000-$19,999)	25,097	32,876	—23.66
Class IV (sales of $5,000-$9,999)	18,729	23,010	—18.60
Class V (sales of $2,500-$4,999)	14,171	14,421	— 1.73
Class VI[a]	3,595	5,414	—33.59
Part time[b]	14,943	13,320	12.18

[a] Farms with a value of farm products sold of $50-$2,499 and a farm operator under 65 years of age who did not work off the farm 100 days or more in the census year.
[b] Farms with a value of farm products sold of $50-$2,499 and a farm operator under 65 years of age who worked off the farm 100 days or more in the census year.



Illinois Crop Reporting Service regions, and type-of-farming areas (indicated by dotted lines).

Scale of farming

State and regional changes in number and size of farms (Table 2) illustrate both the uniformity and nonuniformity of agricultural change throughout the state. Between 1964 and 1969 every crop reporting region in Illinois experienced a decline in number of farms. The size of the decline, however, varied from 3.6 and 3.8 percent in the east and central regions to 12.9 percent in the southeast. Farm size increased in every region, with the largest increase again being in the southeast and the lowest in the central region.

In large part, the variable rates of change reflect the base from which the changes originated (1964). The greatest percentage changes would be most likely to occur in counties at relatively low levels of agricultural development or specialization. For example, in a county with one Class I farm the addition of one more farm of this size would represent a 100 percent increase. This doesn't obviate the usefulness of change figures, but it does show the importance of approaching them with caution.

Tenure status

Except in the southern portion of the state (east southeast, southeast, and southwest regions), the number of farms operated by full owners increased. The greatest increases, far above the state average, were in the east and central regions.

Farms operated by part-owners increased in five of the nine regions. However, they decreased so much in the southern part of the state, particularly in the southeast, that the overall state average declined.

Farms operated by tenants decreased substantially in every region, as did the number of farm operators residing on the farm operated.

Another way of looking at tenure status is to consider the percentages of farms in each region that are operated by full owners, part owners, and operators residing on the farm operated. These percentages support the findings in Table 2. In every region, a larger percentage of the farms was operated by full owners in 1969 than in 1964. Except in the three southern regions, the percentage of farms operated by part owners decreased. The percentage of tenant-operated farms decreased in all regions.

Age of farm operators

As already mentioned, the state increase in number of young farmers (under 25) was a reversal of previous trends. This increase was evident in most of the regions, being greatest (34.5 percent) in the east. In the southeast, however, the number of young farmers declined by 11.6 percent, while in the central region, the number remained unchanged. At the county level, 39 counties showed either no increase or a decline in number of young farmers.

In general, the biggest losses were in the over-65 group, although the regions varied widely in the size of the decline. Also, the number of farmers between 25 and 44 declined in all regions; and the number between 45 and 64 declined in all but the east and central regions.

Off-farm employment

The rapid increase in off-farm employment among the nation's farmers is well documented. Whatever the reason — desire for a higher standard of living, continued existence of the family farm, or desire to spend time away from the farm — more farmers are working off the farm, and those who are doing so appear to be spending more days each year in non-farm employment.

This trend is evident in Illinois also. Every region reported increases in off-farm employment and, except in the southeast, the increases were substantial (Table 2). The east and central regions experienced the greatest increases, both in numbers and in percentages. Employment opportunities and proximity to urban centers, as well as type-of-farming area, would help account for the large increases in these areas.

Economic classes of farms

Consistent with the changes at the state level, every region showed a large percentage increase in number of Class I farms (Table 2). Again, however, regional variations were quite large, the percentage change ranging from 29 percent in the northeast to 116 percent in the southwest.

Other data show that actually the number of Class I farms represents only a small percentage of all farms in the state. In 1969 the northwest had the highest proportion — 21 percent — of Class I farms. None of the three southern regions had more than 9 percent. Although the percentage of Class I farms in the state was not high in 1969, it was much greater than in 1964. In the various regions, the proportion of Class I farms to total number of farms increased by 5 to 6 percent during the five years.

Most regions showed increases in Class II farms and losses in Classes III through VI. The east, central, and northeast regions were exceptions to this trend, experiencing declines in Class II farms and increases in Class V farms. The east also had an increase in Class VI farms, in contrast to the other regions. Except in the southeast, every region experienced an increase in number of part-time farms.

Uneven changes

While the direction of agricultural changes in Illinois may be evident from state figures, the regional figures clearly indicate that most of the changes are not proceeding uniformly. Certain regions are outpacing the others in some types of change. And occasionally, one or more regions are moving in the opposite direction from the rest of the state.

Quite often the departures from the general trends, either in magnitude or in direction, are in the three southern regions of the state, which include 38 of the state's 102 counties. It is therefore obvious that state average figures must be taken with a large grain of salt and that anybody studying agricultural trends in Illinois must be especially concerned with the variations in the southern third of the state.

Table 2. — Changes in Selected Characteristics of Illinois Agriculture, 1964-1969, by Crop Reporting Region

Characteristic[a]	State	Crop Reporting Service region								
		North-west	North-east	West	West south-west	Central	East	East south-east	South-west	South-east
	percent change									
Scale of farming										
No. of farms	— 6.97	— 7.6	— 9.0	— 7.2	— 4.8	— 3.8	— 3.6	— 7.5	— 7.0	—12.9
Av. farm size, acres	7.3	8.6	8.3	7.4	5.1	4.6	5.7	6.5	6.4	10.1
Tenure status										
No. of farms operated by full owners	2.87	5.4	0.0	5.3	2.8	16.2	18.3	— 1.0	— 1.9	— 6.7
No. of farms operated by part owners	— 2.75	6.6	2.7	— 2.7	0.6	3.2	8.7	— 7.9	— 8.8	—19.5
No. of farms operated by tenants	—23.14	—29.6	—21.7	—27.3	—21.1	—21.0	—21.9	—20.5	—17.1	—20.2
No. of operators residing on farm operated	—20.12	—16.3	—20.0	—20.2	—19.5	—18.0	—16.3	—23.3	—21.4	—27.4
No. of farm operators by age group										
Under 25 yr.	11.7	2.2	23.3	12.5	21.4	0.0	34.5	7.5	29.7	—11.6
25-44 yr.	—10.67	—13.6	—16.6	— 9.0	— 5.7	—14.4	—13.9	— 6.9	— 9.3	— 5.6
45-64 yr.	— 2.06	— 1.2	— 4.6	— 3.5	— 0.6	4.8	1.4	— 1.5	— 4.1	—12.6
65 yr. and over	—17.65	—19.0	—12.3	—18.1	—19.0	— 8.9	— 0.5	—26.4	—15.4	—24.8
No. of operators reporting days work off farm	18.5	19.5	23.8	20.6	17.3	25.1	30.3	12.6	15.8	2.8
No. of farms by economic class										
Class I	66.86	90.7	29.3	76.9	80.9	46.1	47.7	96.0	116.3	87.8
Class II	1.61	2.2	—10.6	1.1	6.8	— 9.5	— 9.7	17.5	49.3	31.9
Class III	—23.66	—35.0	—30.4	—26.1	—19.8	—26.3	—24.2	—13.8	—12.5	— 3.5
Class IV	—18.60	—30.3	—21.0	—16.9	—20.1	— 5.3	— 6.2	—20.7	—21.4	—10.3
Class V	— 1.73	—17.9	2.8	— 7.9	— 2.3	5.0	23.7	— 1.9	— 4.3	1.7
Class VI	—33.59	—20.7	—11.6	—21.9	—27.4	— 6.9	21.0	—35.6	—46.2	—55.4
Part time	12.18	29.7	46.3	10.3	12.1	44.9	41.5	3.8	7.6	—15.6

[a] Percent change figures for regions are calculated from averages of the constituent counties for 1964 and 1969.

A typical yam crop.

Yam (*Diocorea rotundata*) tubers.

Protein and Amino Acid Values Of Some Tropical Root Crops

WALTER E. SPLITTSTOESSER and ASHBY M. RHODES

For most people living in year-round hot climates, tropical root crops are a staple of diet. This food preference has been retained by many of the Puerto Ricans and other Spanish Americans who have moved to the Chicago area. Tropical root crops are still a basic part of their diets, even though these crops have to be imported, often at a premium cost.

Are diets consisting largely of tropical root crops nutritionally adequate? Concerned about this question, we investigated the protein and amino acid content of several of the most popular root crops.

Crops studied

The crops investigated were: yams (*Diocorea* species), cassava (*Manihot esculenta*), sweet potatoes (*Ipomea batatas*), and aroids, including taro, dasheen, and tannier (*Colocasia esculenta* and *Xanthosoma sagittifolium*).

Of these, yams are perhaps the most important. Widely distributed throughout the tropics, they are a basic part of the diet for many people. Tropical yams are large white tubers, quite different from the "yams" of the southern United States, which are really sweet potatoes.

Yams have generally been regarded as high-energy, low-protein foods. In some recent studies, however, they have been shown to contain as much as 13 percent crude protein. In utilizable protein value, yams may be only slightly inferior to the major tropical grain staples — rice and maize.

Cassava roots (which are the source of tapioca) are largely storage organs for starch. They are recognized as being low in protein. The aroids are also generally considered to have low protein contents, while sweet potatoes have been found to vary considerably.

The yams, aroids, cassava, and sweet potatoes for our study were grown by Franklin Martin at the Federal Experiment Station, USDA, Mayaguez, Puerto Rico. The crops were harvested at maturity and were analyzed for percent protein and amounts of individual amino acids. Tryptophan could not be measured because it was destroyed during analysis. Cystine was hydrolized and is reported here with the original cysteine as half-cystine.

Table 1. — Crude Protein Content of Nine Root Crops (Dry Weight Basis)

Species	No. cvs. tested	Pct. protein	
		Range	Aver.
Yams			
Diascorea alata	26	6.56-11.22	8.33
D. bulbifera	6	6.66-11.06	9.79
D. esculenta	6	7.85-13.41	9.42
D. rotundata	5	6.34-8.06	7.21
D. trifida	3	6.69-7.63	7.23
Cassava			
Manihat esculenta	6	1.47-5.18	3.08
Aroids			
Colocasia esculenta	4	1.75-11.72	5.03
Xanthasama sagittifolium	6	5.03-8.94	6.52
Sweet patata			
Ipamea batatas	3	2.13-2.69	2.34

Protein content

Protein content of the various yam cultivars ranged from 6.34 to 13.4 percent (Table 1), with most of the cultivars falling in the range of 7 to 10 percent. Sweet potato cultivars had the lowest average protein content, but individual cultivars of cassava and *Colocasia esculenta* were lower in protein than any of the sweet potato cultivars.

Although the aroids are generally considered to be low in protein, several aroid cultivars equaled or exceeded some of the yams in protein content.

Wolter E. Splittstoesser is Associate Professor of Plant Physiology; Ashby M. Rhodes, Associate Professor of Plant Breeding.

Cassava tubers.

Amino acids

Since foods containing 5 percent utilizable, balanced protein can sustain health if eaten in sufficient quantity, some tropical root crops can be considered at least marginally acceptable as protein sources. However, there was considerable variation in amino acid balance among the cultivars tested. Table 2 shows the least amounts of essential amino acids found in the root crops and compares these with the essential amino acids in the reference protein of the Food and Agricultural Organization of the United Nations.

Lysine was deficient in all six of the *Dioscorea esculenta* cultivars tested, a third of the *D. bulbifera* and *Manihot* cultivars, and all of the *Xanthosoma* cultivars. Tyrosine was deficient in five cultivars of *D. alata,* two of *D. esculenta,* one of *D. bulbifera,* all *Manihot* and *Ipomea* cultivars, and all but one each of *Colocasia* and *Xanthosoma.*

Isoleucine was also deficient in many cultivars. However, leucine, which will partially substitute for isoleucine, was well above the minimum requirements in all but *Manihot,* with two *Manihot* cultivars being deficient in leucine. *Manihot* contained the least amounts of essential amino acids, and at least a third of the *Manihot* cultivars were deficient in all of the essential amino acids.

All cultivars tested were deficient in sulfur-containing amino acids. On the other hand, all the crops except *Manihot* contained the essential amino acids leucine, phenylalanine, and threonine in large enough supplies to supplement other plant proteins.

Possibilities for breeding

Yams have never been bred systematically for protein, amino acids, or any other characteristic. However, the wide diversity in the amount of amino acids found among the cultivars and species indicates that selection, even among existing cultivars, might be useful in improving the protein content and amino-acid balance of the crop.

Breeding for increased protein content in cassava has been tried, but it has not been successful. It is not considered a possibility for the future.

Little has been done to screen aroid varieties for higher protein, but the wide diversity found in protein content indicates that selection of existing cultivars might be useful. The sweet potato cultivars tested here were low in protein but as much as 11.8 percent protein has been found in cultivars tested elsewhere. Many cultivars tested worldwide have contained excess amounts of all the essential amino acids except tryptophan and total sulfur amino acids.

Since all root and tuber crops lack sufficient sulfur amino acids, increasing the amounts of these amino acids should be emphasized in selection.

Table 2. — Minimum Amounts of Essential Amino Acids in Nine Root Crops as Compared to the FAO Reference Protein

Species[a]	Grams of omino acid per 100 grams of protein[b]								
	Lysine	Methionine	Half-cystine	Tyrosine	Valine	Isoleucine	Leucine	Threonine	Phenyl-alanine
Diascorea alata (26)	4.7	1.5(26)	0.1(26)	2.2(5)	4.2	3.6(6)	7.5	3.5	5.5
D. bulbifera (6)	3.4(2)	0.6(6)	0.3(6)	2.4(1)	5.5	4.2	5.6	4.1	5.5
D. esculenta (6)	3.6(6)	1.3(6)	0.3(6)	2.6(2)	4.0(1)	2.7(5)	6.4	3.9	4.2
D. rotundata (5)	5.3	1.4(5)	0.1(5)	2.8	4.6	4.1(1)	7.5	3.9	6.0
D. trifida (3)	4.6	1.2(3)	0.1(3)	2.9	4.9	3.9(2)	8.2	4.4	5.2
Manihot esculenta (6)	2.9(2)	0.7(6)	0.0(6)	0.8(6)	2.5(2)	1.5(6)	2.6(2)	2.3(2)	1.5(2)
Colocasia esculenta (4)	4.2	1.1(4)	0.1(4)	2.4(3)	5.5	3.3(3)	7.7	4.5	4.0
Xanthosoma sagittifolium (6)	3.7(6)	0.9(6)	0.6(6)	1.5(5)	6.0	3.1(6)	6.3	4.2	4.2
Ipomea batatas (3)	4.6	1.5(3)	0.0(3)	1.2(3)	6.9	4.8	7.7	4.8	4.5
FOA Reference Protein	4.2	2.2	2.0	2.8	4 2	4.2	4.8	2.8	2.8

[a] Numbers in parentheses are the number of cultivars analyzed.
[b] Numbers in parentheses indicate the number of cultivars below the FAO minimum. Tryptophan was not measured.

Atherosclerosis and Plasma Lipoproteins

TOSHIRO NISHIDA

TWO PATHOLOGICAL changes in the aorta are associated with human atherosclerosis: the deposition of cholesterol and other lipids and an abnormal organization of the fibrous material in the aorta.

Most of the cholesterol and many other lipids in the atherosclerotic lesion are derived from blood plasma. By themselves, lipids are largely or entirely insoluble in water. However, almost all the lipids in plasma are bound to proteins which, having a strong affinity for water, render the lipids water-soluble. Such lipid-protein combinations are called lipoproteins.

In spite of the importance of lipoproteins, their structure and metabolism are still unknown. The Department of Food Science is therefore conducting studies to learn more about lipoproteins and their role in the development of atherosclerosis.

At first we tried to clarify the effects of nutritional factors on lipoprotein metabolism and on atherosclerosis, with chicks and rats as experimental animals. However, we soon realized that this was a limited approach, for the development of atherosclerosis is extremely complex and is not necessarily related to diet. We therefore focused our attention on the fundamental properties of plasma lipoproteins.

Structure of aorta

To understand the role of the lipoproteins in atherosclerosis, we need to know something about the structure of the aorta. The normal aorta, like any other artery, consists of three layers: the intima, the media, and the adventitia.

The intima, or innermost layer, can be subdivided into a lining of thin cells (endothelial cells) and a thin layer of connective tissue matrix and internal elastic membrane. The media is made up of smooth muscle cells embedded in a fiber network of the protein collagen, narrow elastic membrane sheets, and other connective tissue material. The adventitia, or outermost layer, supports the entire artery.

Only the intima and inner media are affected by atherosclerotic lesions. The earliest lesion is a fatty streak, consisting of a patchy accumulation of lipids. Fatty streaks occur in the aortas of nearly all children by the age of three. They do not in themselves cause disease but they may become more serious later.

In the more serious lesions, cells accumulate within the intimal space and produce fibrous scar tissue. Such lesions may be present for many years without any symptoms. However, they may become complicated by necrotic centers, thrombosis, ulceration, hemorrhage, calcification, and a further deposition of lipids. As a lesion grows, it may impede the blood flow or cut it off entirely.

Smooth muscle cells

The cells primarily involved in atherosclerosis are the smooth muscle cells of the media. These cells have many functions: They contract, migrate, proliferate, and synthesize and secrete connective tissue components such as elastin, collagen, and mucopolysaccharides.

The elastic membranes surrounding the smooth muscle cells in the media are composed mainly of elastin. Their elasticity and the contractile properties of the smooth muscle cells allow the artery to expand and contract in response to the pulsation of the blood.

Nourishment of the aorta

Like all body cells, the cells in the aorta need a constant supply of nutrients and oxygen. Small arteries get these substances by direct permeation from the blood. For larger arteries, however, direct permeation is not enough to nourish the adventitia and even some of the outer media. Therefore, the outer part of the artery receives nutrients and oxygen from small blood vessels which run through the adventitia.

Unused nutrients and plasma components, as well as the products of metabolic action, slowly drain into adventitial blood capillaries. If the influx of plasma components exceeds their use and drainage for any reason, these substances tend to accumulate in the aorta.

Disease development

The earliest microscopic change in the aorta is a widening of the subendothelial layer of the intima, due to the accumulation of lipids. Lipid droplets also accumulate inside the smooth muscle cells in the innermost layers of the media. Next, the internal elastic membranes begin to degenerate, allowing smooth muscle cells to migrate and multiply at the developing lesion.

We do not know why the elastic membrane breaks down, or how smooth muscle cells migrate and multiply. However, we do know that these effects may be accelerated by high blood pressure and other factors that increase the entry of plasma components. The result may be an edema which separates the local tissue without damaging it, and which causes smooth muscle cells to proliferate and form more connective tissue. Although the edema may eventually be cleared, lipids are left in the intima because the drainage system is not sufficient to remove them. When lipid concentration in the blood is high, more lipids accumulate in the intima.

With lipid accumulation in the intimal muscle cells, the increase in size of the lipid droplets eventually

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causes the cells to degenerate. Cells also degenerate when nutrients are not adequately diffused through the thickened intima.

The debris of these dead cells, plus the extracellular lipids and other plasma components, form necrotic (dead) centers in the fatty deposits of the intima. In a healing attempt, the intima produces more smooth muscle cells and eventually more connective tissue. These form fibrous plaques over the fatty deposits, increasing their thickness. This sequence of events can repeat itself if blood lipid concentrations remain high and if the injury to the endothelial cell lining is not repaired or the lining is continuously damaged by high blood pressure or other factors.

The plaque does not cause symptoms until the affected artery becomes narrow or obstructed. An obstruction may become very severe if a blood clot (thrombosis) forms on the plaque. In advanced lesions, a microcirculatory system often develops in an attempt to nourish the cells, but it is disrupted by high blood pressure, resulting in hemorrhage. Occasionally, a plaque may weaken the artery wall, causing it to rupture and hemorrhage into the tissue. The necrotic tissue often becomes calcified in the later stage of atherosclerosis.

The lipids

The major lipids that accumulate in the artery wall are cholesterol and its esters. The synthesis of phospholipids is also accelerated in the atherosclerotic aorta. This is to be expected, since the multiplication of smooth muscle cells in the intima requires phospholipids as the most important constituents of the cell membranes. Cholesterol, the next most important constituent, is derived from plasma.

The accumulation of cholesterol in intimal smooth muscle cells indicates that no mechanisms exist to control the uptake of cholesterol or convert it to easily removed water-soluble products. The free cholesterol taken up by the cell is associated

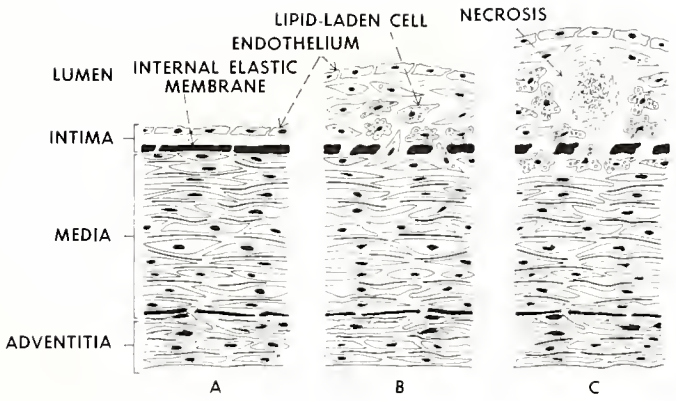


Diagram showing the structures of (A) normal aorta and of aortas with (B) proliferative and (C) advanced lesions.

with the membranes of the cell surface and the intracellular organelles.

Cholesterol esters taken up by the cells are converted to free cholesterol. However, only a limited amount can be accommodated by the membranes. The excess cholesterol tends to crystallize and is highly toxic in that form. The only way that a large amount of cholesterol can be accommodated without immediate toxicity is for an enzyme to convert it to the ester form, which can be incorporated into lipid droplets. The effect of free cholesterol on the structure and other properties of lipid particles is being studied in our laboratory.

Lipoproteins

Several classes of lipoproteins exist in plasma. The largest lipoprotein particles are the chylomicrons, which are involved in transporting dietary lipids. The next largest are the very low density lipoproteins. Low density lipoproteins (LDL) contain the highest amounts of cholesterol and cholesterol esters. High density lipoproteins (HDL) contain the most proteins and phospholipids. The differences in density are due to varying proportions of relatively heavy protein and relatively light lipids. Although the role of lipoproteins is not understood, only LDL seem to be directly involved in atherosclerosis.

Various research groups have demonstrated that atherosclerotic plaques contain lipoproteins with properties similar to those of LDL. The retention of LDL in the aorta may be due to their interaction with acid mucopolysaccharide, a component of the connective tissue matrix.

Utilizing sulfated polysaccharides as model compounds, we have extensively investigated the mechanism by which lipoproteins interact with these compounds. We have clarified the complex involvement of lipoprotein positive and negative charges and the role of divalent mineral ions such as calcium and magnesium ions. As calcium ions accumulate, an insoluble complex may be formed.

Uptake and accumulation of LDL in smooth muscle cells may be due to the cells' inability to metabolize either cholesterol or protein. It has been recently reported that LDL promotes growth of smooth muscle cells in cell cultures, probably because of the protein. LDL protein, when separated from the lipid, tends to aggregate much more than do the proteins in other lipoproteins. We are currently characterizing this unique property.

Recently we initiated a study of elastin in the aorta, since it appears to play an important role in the accumulation of lipids, especially cholesterol esters, outside the cells. We are also investigating the role of a certain enzyme — lecithin-cholesterol acyltransferase — in the esterification of cholesterol. This enzyme is normally present in blood. However, it appears to penetrate the aorta and may esterify the cholesterol in lipid particles outside the cells.

With these studies, we expect to increase our understanding of lipoproteins, particularly as they are associated with atherosclerosis. The information can then be used in efforts to prevent or reverse this serious disease.

Simple lean-tos provide the Agta shelter.

Lessons in Family Living From a Primitive Society

JEAN TRELOGGEN PETERSON

In an era when many observers are lamenting the disintegration of the American family, it is enlightening to observe the family life of our primitive contemporaries. While these people do not necessarily reflect our values, they do furnish examples of well-integrated, functioning families. In addition, their preindustrial communities allow us to examine the effects of environment and basic survival needs on family living.

My study of preliterate family life was carried out over a two-year period in the Palanan Bay area on the isolated northeast coast of Luzon in the Philippines. This forested, mountainous region is inhabited by two populations: The Palanan peasants, who number about 10,000, gain their living mostly by tilling the major river valley and coastal strip. The 800 Agta, the focus of my study, engage primarily in hunting, fishing, collecting, and trading with their peasant neighbors.

The basic Agta domestic unit, like ours, is the nuclear family (parents and children). Like us, they are a mobile people. By focusing on the economics of family living, especially sex roles, age roles, and the role of the extended family, we can learn a great deal, not only about the Agta, but also about ourselves.

Agta sex roles

As hunters and fishers, men are the chief protein producers. They do their hunting singly or in groups of three or four, and may be away from camp for several days. Women and small children never go on actual hunting jaunts, although the nuclear family may move as often as every week to camp nearer sources of food.

The men use bows and arrows that they have made themselves, with boar and deer being the chief game. Occasionally hunters bag smaller species, such as monkeys, snakes, and birds, as the opportunity arises. Traps and snares are also set to obtain all species, but are less reliable than bows and arrows. Men may collect leaves, grasses, or fruit along the trail, but they make no serious effort to provide these foods.

Fish, which are abundant both on the reefs and in the rivers, are as important a source of protein to the Agta as game. Men fish in pairs or alone, using simple homemade equipment. Slings and spears are fashioned from wires and strips of innertube acquired from peasant neighbors and local traders; goggles are made of wood and the glass from Japanese fishing floats which wash up on the beach.

Agta women are the specialists in carbohydrate and vegetable food production. They collect wild roots and tubers, leaves, grasses, and fruits. Some of these may be stored for several days, and a few species of roots may be stored in pits for as long as two or three months. Most carbohydrate, however, is obtained in trade with their peasant neighbors. Trading is a task shared by men and women, the Agta providing excess protein in exchange for cultivated roots and grains.

Women also regularly collect shellfish and they occasionally fish. For the most part, however, food production is sexually specialized, with women providing collectables and men the rest of the diet. Women also are the primary house-builders, erecting simple lean-to shelters which are abandoned with each move. This division of labor permits women to bear and nurse infants while remaining productive members of their society.

Agta age roles

Agta children are also productive citizens. Like American children, they spend much of their time learning the skills critical to their survival. Boys, beginning around age four, learn how to fish from other boys. By the time they are seven they will begin to practice archery and will occasionally accompany their fathers on hunting trips.

Girls daily accompany their mothers, grandmothers, aunts, or older sisters on their rounds of duties, learning through observation and practice. By puberty they are knowledgeable in the foods of the area, can weave baskets and mats, and can build houses.

The important difference, then, between the roles of Agta and American children is that while Agta children learn they also produce food. Often, when adults have been unsuccessful in their daily food quest, families have eaten well on shellfish, fish, and vegetable foods provided by children. One seven-year-old fur-

Jean Treloggen Peterson is Assistant Professor of Family Relationships.

nished the bulk of his family's protein for three months, while the father cared for younger children and the dying mother.

Children also perform many tasks important to domestic maintenance. They cook, police the camp site, gather firewood, keep the fire going, carry water, and tend younger siblings. I, a Westerner with few survival skills, often found my well-being competently assured by a three- or four-year-old child who would warn me away from stinging plants, maintain my camp fire, or show me how to prepare native foods.

The aged, too, are actively engaged in the economic life of their community. When their physical strength begins to fail, they turn from the strenuous tasks of the young to other equally important, but less arduous activities.

Characteristically, old people maintain small garden plots. Bit by bit they clear the forest, burn the refuse, and plant yams, manioc, corn, pineapples, sugar cane, and other choice foods. They then provide these foods to their younger neighbors, in exchange for fish and game. One feeble old couple laboriously dipped up sea water and boiled it down to obtain salt for themselves and their neighbors.

Old men maintain traps and snares for forest game, and fish with lines and nets if they can borrow these items from the neighboring peasants. The aged also help care for children, gather firewood, and do other domestic tasks. They take great pride in their contributions, and glory in the respect they win from younger people.

It is apparent that an Agta family is critically dependent on all its members — male and female, young and old. On any given day a hunter or collector may fail to obtain food. It is important, therefore, that everybody make a food-producing effort according to his abilities. In exchange, each person receives a fair share of all available food. The Agta recognize the importance of this arrangement, and value all family members, not only with affection but also with appreciation for their economic contributions.

The extended family

Just as the immediate family helps to alleviate daily variations in food supply, so the extended family helps to counteract the effects of seasonal and long-term shortages. Seasonal variation results from the fact that fish are less abundant during the rainy season (September through January) and game is less prevalent during the dry season (February through August). Long-term food shortage may prevail in a localized area due to migration of game, flooding, or typhoons.

Regional variations in food supply also exist. In the southern part of the Palanan Bay drainage, reef fish are abundant, but there is a dearth of river fish, game, and arable land, and relatively poor trade relations with the peasants.

The inland area has an abundance of deer, river fish, and arable land, and trade relations there are very good. However, boar are relatively scarce and there is no access to the reef. In the north, boar abound, reef and river fishing are relatively good, a fair amount of land is available, and trade with peasants is relatively lucrative.

Marriage practices alleviate this protein variability. All families have some member who has married outside the home territory, thus providing them with access to food resources in another area. Males generally live near their wives' families and thus become familiar with game habits and fishing sites in two areas. The entire extended family is then assured of food in hard times.

As an example, Dosing, who grew up in the north, married a woman from the south. After his marriage, he joined his wife's family in the south and spent several months under her father's tutelage, familiarizing himself with the reefs in the area. At least twice a year visits are exchanged with his kinsmen to the north. In addition, his siblings, parents, aunts, and uncles join him in the south to fish when game is scarce in the north; and his wife's relatives accompany him to the north when fishing is not good.

With long engagement periods, the strong support of two extended families, and the sexual division of labor, Agta marriages are unusually stable, with only a 4 percent divorce rate.

Agta and American families

Several of the contrasts between Agta family life and ours are particularly noteworthy:

1. While the Agta maintain a sexual division of labor to accommodate the demands of child bearing and child care, all women as well as men are food producers. Husbands and wives seek not only companionship and love with each other; they depend on each other economically. By contrast, many American women are not gainfully employed and so do not directly contribute to the economic support of the family.

2. Agta children and aged perform tasks which maintain their self-respect and their importance in the community. Children receive a good deal of independence at an early age, and the aged retain it until death. American children are expected to remain relatively dependent (and an economic burden) for at least 18 years. The aged in our country are expected totally to abandon productive life.

3. Agta extended family ties, as well as nuclear family ties, are nurtured and valued. Distance and education have created growing gaps in American extended families. Work, too, has impinged on our family life. An Agta adult needs to spend only three to five hours a day in work. The Agta value work, but appreciate their ample leisure in the companionship of loved ones.

We, of course, must adjust to a very different environment and technology than must the Agta. However, Agta adaptation may give us clues for improving our own family life and reducing our problems of divorce; the lack of a satisfying role for many adolescents, old people, and women; and an apparently disintegrating family.

Give Your Christmas Tree "The Cut That Refreshes"

J. J. JOKELA and L. B. CULVER

EVERY CHRISTMAS season public service messages tell us to display our Christmas trees in water after first cutting an inch or more from the bottom of the trunk. Almost invariably a diagonal cut is suggested.

A fresh cut is indeed essential, for the surface of the original cut can dry out or be fouled by resin. But must the cut be diagonal, rather than square? A brief test in the Department of Forestry suggests that the answer is no.

Sixteen trees studied

Sixteen 5- to 8-foot Scotch pine were tested in a vacant classroom during the Christmas, 1972, holidays. Eight trees had been freshly cut and the others had been allowed to dry to a foliage moisture content of 95 to 125 percent, resembling the condition of stored but acceptably fresh trees. Four randomly selected trees from each of the two groups received diagonal or 45° angle cuts which removed 1 to 3 inches of trunk base. The other trees received right-angled or square cuts.

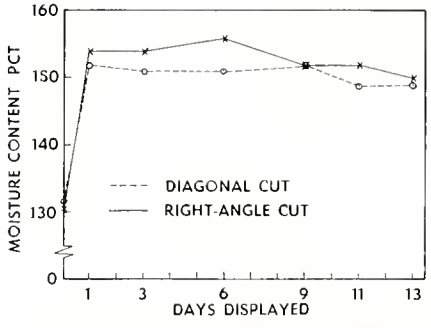
Buckets served as tree stands, with water immersing several inches of the trunk bases. Plastic sheeting was fastened over the tops of the buckets to minimize direct evaporation of the water supply. The amount of water required to bring the water level to marked initial levels, measured daily, showed uptake or consumption by the trees. Foliage moisture content was measured when the trees were set in water, then 24 hours later, and finally at 2- and 3-day intervals until the test ended on the thirteenth day.

Throughout the period, room temperatures fluctuated from 72° to 85° F., averaging 77°; relative humidity varied several percentage points from an average of 37 percent. These conditions were perhaps more severe than those of the average house during the Christmas season.

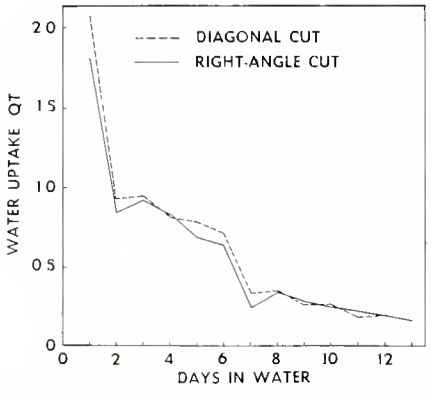
Responses are similar

Since all trees had moisture contents above the critical level (80 to 85 percent) for water uptake, they regained their natural freshness within 24 hours. Throughout the 13 days they stayed at a safe moisture level, well above the match ignition point of 65 percent.

The trees took up water in a normal pattern with a high initial consumption rate and then a declining rate. In the first 2 days they consumed more than a fourth of their total requirement for the 13-day period.



Foliage moisture content of Scotch pine trees with two types of cuts. All trees maintained moisture contents well above the match-ignition level. (Fig. 1)



Regardless of cut, trees had about the same moisture requirements. On the average, the trees took up 2 quarts of water in the first 24 hours. (Fig. 2)

Diagonal vs. square cut

Both types of cut kept the trees satisfactorily fresh, as indicated by needle moisture content and daily water uptake (Figs. 1 and 2). There is thus no reason to recommend the diagonal over the right-angled cut.

Actually the right-angled cut is preferable for a number of reasons: (1) It is much easier to make a right-angled cut than a diagonal cut. (2) There is less interference between saw and lower branches. (3) The flat surface of the right-angled cut is easier to pierce with the anchor point commonly found in commercial stands. (4) The flat surface will remain immersed in shallower water.

Freshness important

Whichever cut is used, the important thing is to select a fresh tree and keep it fresh. If a tree contains less than 80 to 85 percent moisture to start with, it will lose 5 to 15 percentage points of moisture a day even with its butt immersed in water. Within a week it will be highly flammable.

To maintain freshness, the right kind of stand is essential. Many stands hold less than a quart of water; yet the trees in the test consumed, on the average, 2 quarts in the first 24 hours and averaged a quart a day throughout the first week. A stand should have a big enough reservoir for the size of tree to be used. A 3- or 4-quart capacity is not excessive for a 6- or 8-foot tree. The stand should hold the tree erect without tipping.

By choosing a fresh tree and keeping it fresh, you can help protect your family from the tragedy of fire in the coming holiday season.

The authors are both Associate Professors of Forestry. Measurements given in this report were collected by a student, Kimball L. Mancke, who graduated last June.

Plants' "Self" Recognition May Aid Disease Control

JACK D. PAXTON

The darkened areas in these soybeans are due to phytoalexin production, induced by a fungal protein. Soybean at lower right does not contain phytoalexin.

VACCINATED PLANTS? Probably not, but a seed treatment somewhat like immunization of animals may be feasible as we learn more about plants' ability to recognize "self" and "non-self."

That animals have a highly developed mechanism for distinguishing self from non-self has been known for some time. This mechanism is not yet fully understood, but it includes the production of antibodies that can bind to specific substances, principally proteins.

The production of antibodies is responsible for much of the disease resistance in animals and human beings. It is also the main cause of allergies to various substances (again often proteins). And it largely explains the phenomenon of graft rejection, which increases the difficulty of organ transplants.

Although antibody production has not yet been proved in plants, it is known that plants can recognize self and non-self. As evidence, there are numerous examples of graft compatibility and incompatibility in a wide range of plants. Generally plants will accept grafts of self material, but will reject grafts of non-self (somewhat as the human body rejects a heart transplant). However, there are examples of unusual compatibility, such as the grafting of chestnut on pin oak.

Other evidence that plants recognize self and non-self is found in pollen compatibility and incompatibility. Pollen compatibility is narrower than graft compatibility, and is generally confined to species within a genus. In fact, taxonomists use this property in classifying plants.

Jack D. Paxton is Associate Professor of Plant Pathology.

The ability to recognize self and non-self may be fundamental to the perpetuation of species and to disease resistance in plants. There are many similarities between the way that pollen germinates and grows into the stigma of a flower, and the way that a fungal spore germinates and grows into the plant leaf or root. Although there are several possible explanations for this recognition phenomenon, evidence is accumulating that an antigen-antibody type of reaction may be involved, at least in some situations.

Australian scientists (Knox and others) took pollen that was compatible with Populus species and soaked it in water. Substances that soaked out of the pollen were applied to Populus stigmas, which then accepted pollen that had previously been incompatible. There are indications that the water-soluble substances in pollen are proteins and that they function in "recognition."

Research workers in this country (Doubly, Flor, and Clagett) have found that the fungus causing flax rust attacks only plants containing a certain antigen (protein) in common with the fungus. DeVay has found similar phenomena in other plant diseases. He believes that common antigens between host and parasite may explain the ability of many microorganisms to attack only specific plants.

In our laboratory we have protected soybean plants from the fungus *Phytophthora megasperma* var *sojae* by inoculating the plants with *P. cactorum*. This second microorganism is closely related to *P. megasperma* but is not pathogenic on soybeans. In some respects, this type of inoculation is like using the cowpox virus to protect humans against smallpox.

We found that *P. megasperma* var *sojae* produces a protein that causes the soybean plant to manufacture phytoalexins (see illustration). These antibiotic compounds help protect the plant from invasion by microorganisms much as antibody production helps protect your body from infection. Possibly the protein produced by the fungus carries information that is recognized by the Rps gene in soybean plants. This gene specifically confers resistance to *P. megasperma* var *sojae*.

A new race of this fungus, which attacks soybean plants even when they carry the Rps gene, has been recently found in Ohio. As a result, it becomes more imperative that we find out why plant diseases develop and what makes plants disease-resistant, so that we can control diseases before they become severe.

We are now working to identify the fungus protein and the phytoalexins it causes the soybean plant to produce. With knowledge about these substances, we will better understand disease resistance in plants. Plant breeders will then be able to select more efficiently for disease resistance. And, as already suggested, a seed treatment that will protect the plants against infection may be a possibility.

Vibration of Tillage Tools:

A possible approach to the problem of using tractor horsepower more efficiently

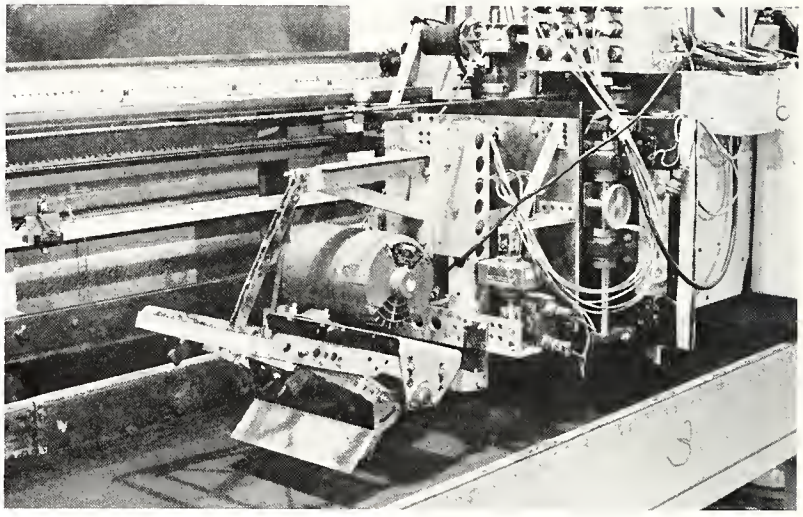
J. A. WEBER and W. W. BRIXIUS

As TRACTOR engine horsepower has increased, so has the difficulty of putting it to good use. Tractive efficiency (drawbar horsepower divided by axle horsepower) is 65 to 75 percent on firm soil and 50 to 60 percent on tilled soil. This means that as a plow is pulled through the field, 25 to 35 percent of the tractor's energy output is lost creating the large tractive force between the drive wheels and the soil. The weight or ballast that must be added to minimize this loss can cause excessive compaction of the soil.

There has been a continual search for ways to till the soil with less tractive effort. Drawbar pull could be reduced and weight could be removed from the tractor if part of the energy for tilling the soil could be transferred from the tractor to the tool through the power takeoff instead of the wheels.

Several researchers have shown that vibrating a tillage tool reduces the force needed to pull it through the soil. The total energy requirement is generally not reduced, but the energy to vibrate the tool can go to the implement through the power takeoff. Unfortunately, attempts to vibrate the tool have not reduced the draft force at ground speeds normally used in farming.

The direction, amplitude, and frequency of the tool's oscillation affect the draft force. Several theories have been proposed to explain this phenomenon. Research is being conducted in the Department of Agricultural Engineering to find out which of the proposed theories can be put to use in applying tool vibration at higher ground speeds.



A model tool was operated both with and without vibration in an indoor soil bin to test the effects on soil movement. (Fig. 1)

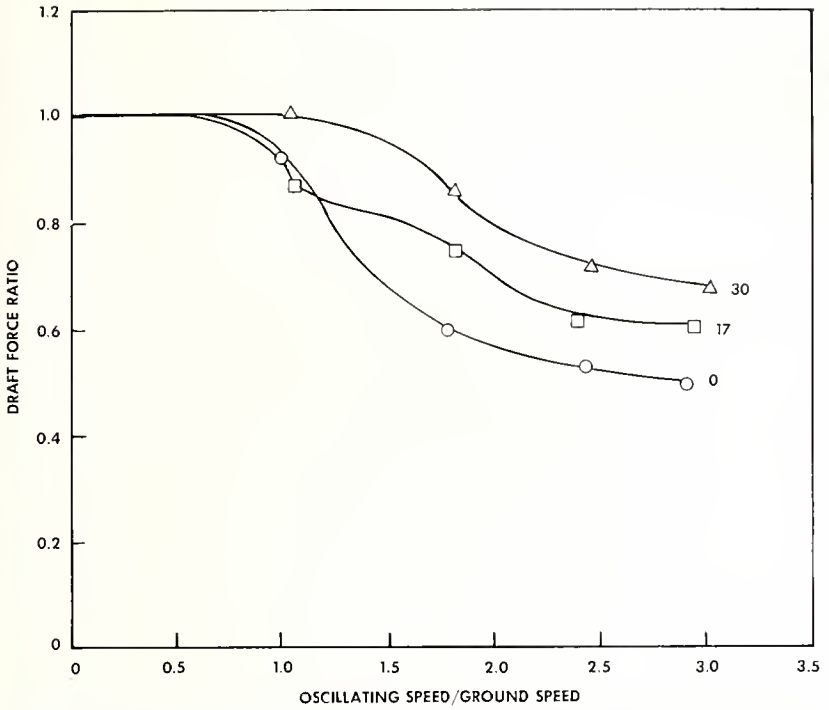
We started by studying the way soil fails and moves in front of both vibrated and non-vibrated tools. Our studies were conducted with a model tool in an indoor soil bin (Fig. 1). The tool was inclined 45 degrees to the soil surface; ground speed in the bin was equivalent to a field speed of 1 mile per hour. To determine if direction of motion was important, the tool was oscillated at angles of 0, 17, and 30 degrees downward from the horizontal.

Figure 2 compares the draft force of the vibrating tool with the force of the same tool when it was not vibrated. This particular test was conducted on a brittle soil. Draft force decreased as frequency of oscillation increased and as oscillating speed of the tool increased relative to ground speed. When the tool was moved back and forth in the horizontal direction, draft force was reduced as much as 50 percent. The downward motions of 17 and 30 degrees were less effective than the horizontal direction in this brittle soil. In clayey, more plastic soil, however, the 30-degree downward motion was most effective at the higher frequencies.

High-speed movies were taken of the tool and soil interaction. Before a test run, the soil was cut away to the path of the side of the tool and grid lines were placed on the vertical wall of soil. The camera was focused on the grid while the tool passed through the test area.

The non-vibrating tool failed the brittle soil in shear planes similar to those in Figure 3 (left). The soil

J. A. Weber is Professor of Agricultural Engineering; W. W. Brixius was formerly a Research Assistant.



Effect of vibration on draft force of a tillage blade operated in a brittle soil at angles of 0, 17, and 30 degrees downward from the horizontal; expressed as the ratio of the vibrating force to the non-vibrating force. (Fig. 2)

broke out in blocks, it was cloddy, and there was little pulverization. When the tool was vibrated at the higher frequencies, the soil flowed over the tool as in Figure 3 (right). A general shear took place in the soil and there was maximum pulverization.

Vibration was less effective in plastic soils. They broke out in long strips at all frequencies, and the vibration did not significantly affect amount of pulverization.

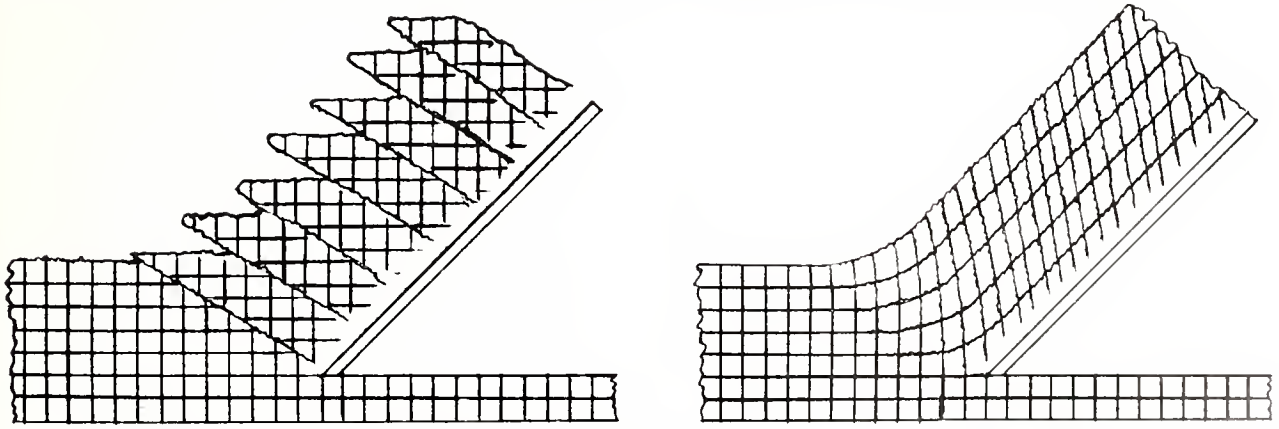
In this study, the amount of draft reduction was related to the percentage of time the tool was not in contact with the soil. The applicable theory says that the tillage process with vibration is divided into two periods — one when the force on the tool is zero and another when the force is the same as if the tool were cutting the soil at ground speed plus peak oscillation speed. (Peak oscillation speed is the amplitude multiplied by angular velocity.) To check this theory, force predictions were made by combining the force for this cutting speed with a zero force for the period of non-contact as shown by the films. For fore and aft motion, the measured forces could be predicted within 10 percent. No other theory proposed in the literature seemed to apply.

Unfortunately, as ground speed is increased at a given tool frequency, the amount of time the tool is not in contact with the soil decreases. Frequency or amplitude can in turn be increased but only to a limited degree, for the increased acceleration of the parts of a field machine increases both the total power required and the difficulty of designing a machine that will not shake apart.

In this study, the tool had a harmonic motion so the average forward and rearward velocities relative to the implement were equal. It may be possible to devise a quick return mechanism that will increase the time of no contact between the tool and the soil.

Vibratory tools are now used to lay telephone and electric cables under lawns. The speed of these machines is less important than preserving the original condition of the lawn. This can be done because the machine is light in weight and does not have to develop high tractive forces.

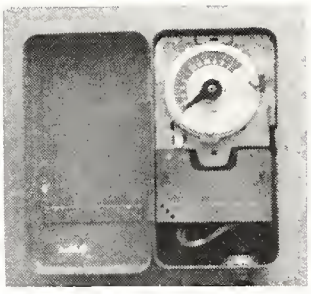
The decreased draft and the control of soil pulverization that can be obtained by tool vibration make it a potential alternative to present tillage methods. Tool vibration will continue to receive attention by those who develop farm machines.



With a non-vibrating tillage tool, brittle soil broke out in blocks as diagrammed at left. When the tool was vibrated, the soil flowed over the tool, as shown at right. (Fig. 3)

Drying Corn By the Clock

GENE C. SHOVE



GRAIN BINS with perforated drying floors are popular because large amounts of shelled corn can be dried with minimum handling. However, drying often takes so long that overdrying may result.

Corn in the bottom of the bin will finally reach a moisture content in equilibrium with the air supplied. If a temperature rise of 20° F. is used for drying, the 80 percent relative humidity that usually exists during harvest will be reduced to about 40 percent, and corn will be dried to less than 10 percent moisture content. A greater temperature rise will dry the corn even more. This overdrying increases fuel usage and reduces grain weight.

Overdrying can be prevented by limiting heat input to maintain an average relative humidity in equilibrium with a desired final grain moisture content. Experiences with low-temperature drying have shown that shelled corn can be dried to 15 percent moisture with about a 5° F. temperature rise applied continuously, if average daily relative humidity is about 80 percent. Heaters producing greater temperature rises must be limited to less than continuous operation.

The heat produced by intermittent heater operation is expressed in Fahrenheit-hours per day. To determine F.-hours, temperature rise is multiplied by the number of hours out of each 24 that the heater is operated. For example, a 5° temperature rise applied for 24 hours would equal 120 F.-hours per day. So would a 30° temperature rise applied only 4 hours. Table 1 gives various combinations of temperature and heater operation that will produce the number of F.-hours needed for drying corn (assuming a relative humidity of 80 percent).

To control the heater operating time, you can install a 24-hour timer in the heater control circuit. Before setting the timer, use a mercury-in-glass thermometer to accurately determine the temperature rise produced by the heater and fan after the grain is placed in the bin.

Precise final grain moisture content can be achieved by periodically determining the moisture content of grain samples from the bottom of the bin. The results will serve as a guide for adjusting heater operation time. If grain samples cannot be obtained from the bottom of the bin, the operation times in Table 1 can be adjusted upward for an average relative humidity greater than 80 percent, and downward for a lower average relative humidity.

Tables 2 and 3 give data for three bins operated with limited heat input in 1972 and two bins heated continuously. In all five bins corn dried to desired moisture levels. Weather conditions in central Illinois during October, 1972, were reasonably favorable for drying as indicated by corn moisture contents achieved with 48 and 132 F.-hours per day by November 1. Weather during November and December was very unfavorable to drying and more energy was required (168, 188, and 216 F.-hours). In general, the later that drying is completed, the more energy will be needed, since average relative humidity increases as winter approaches.

Heaters producing appropriate temperature rises can be selected for new grain-drying facilities, and time clocks may not be needed. However, time clocks are convenient for limiting heat input from existing heaters that produce greater temperature rises than necessary.

Table 1. — Heater Operation Time to Dry Corn to 15 Percent Moisture, With Average Air Relative Humidity of 80 Percent

Temp. rise from heater and fan	Heater operation time	Daily energy input[a]
	hours	*F.-hours*
5°F.	24	120
10°F.	10	128
15°F.	6	126
20°F.	4	120
25°F.	3½	128
30°F.	3	132
35°F.	2½	130

[a] Includes heat from friction of air passing through fan while heater was not operating (typically a temperature rise of about 2° F.).

Table 2. — Moisture Content of Dried Corn in Lower Part of Bins With Limited Heat Input

Grain depth, ft.	Daily energy input[a]		
	132 F.-hr.[b]	168 F.-hr.[c]	188 F.-hr.[d]
	percent moisture content		
5	13.3	14.9	14.6
4	13.4	14.9	13.6
3	13.7	14.9	13 3
2	13.8	14 8	13.0
1	13.8	14.8	13.1
Floor	14.0	14.9	13.3

[a] Includes heat from friction of air passing through fan while heater wos not in operation (typically a temperature rise of about 2° F.).
[b] 9° F. rise from 7:00 a.m. to 7:00 p.m. at Jacksonville. Moisture content on November 1, 1972.
[c] 26° F. rise from 11:00 a.m. to 4:00 p.m. at Tuscola. Moisture content on November 20, 1972.
[d] 16° F. rise from 9:00 a.m. to 2:00 p.m. and from 9:00 p.m. to 2:00 a.m. at Champaign. Moisture content on November 10, 1972.

Table 3. — Moisture Content of Dried Corn in Lower Part of Bins With Continuous Heat Input

Grain depth, ft.	Daily energy input	
	48 F.-hr.[a]	216 F.-hr.[b]
	percent moisture content	
5	17.2	13.0
4	16.0	12.9
3	15.4	13.0
2	15.3	12.8
1	15.5	12.7
Floor	15.9	12.7

[a] 2° F. temperature rise continuously at Champaign. Moisture content on October 30, 1972.
[b] 9° F. temperature rise continuously at Jacksonville. Moisture content on December 6, 1972.

Gene C. Shove is Professor of Agriculturol Engineering.

Selection of Self-Propelled Combines

Machinery costs weighed against costs of delayed harvest provide guidelines for choosing proper combine capacity

DONNELL HUNT

SELECTING the proper size of combine depends on balancing the costs of machinery against the costs of time, for time does have costs when it is associated with harvesting. This association, referred to as timeliness, is the most important consideration in the selection of combine capacity, although it has not been completely defined in dollars.

Timeliness costs

Timeliness costs are computed as the value of grain lost because it was not harvested at the optimum time. Premature harvesting causes losses due to high moisture and low grain quality. Delayed harvesting causes field losses and losses in weight, which reduce the monetary value of the crop.

Ideally, a farmer should have enough combine capacity to harvest the grain that is ready in one day, but combines cost too much for such capacity to be economic. Instead, one can try to keep timeliness costs at a minimum.

Careful management of seeding will ease the timeliness problem and reduce machinery capacity needs. For example, plantings can be staggered and varieties with different maturation dates can be seeded. To some extent, limited seeding capacities and weather interruptions during seeding will naturally string out the optimum harvesting time in the fall. However, a 10-day difference in seeding usually shrinks to only a few days by fall.

The value of the crop being harvested affects timeliness costs and thus is a factor in combine selection. Untimely harvesting is not very costly when the price of the crop is low.

Table 1. — Optimum Combine Size, in Feet, With Labor at $2 an Hour, Based on Number of Machine Acres, Crop Value, and Purchase Price[a]

Crop value per A.	Purchase price per ft.	50 A.	100 A.	200 A.	400 A.	600 A.	800 A.	1000 A.
		Combine size, feet						
$50	$ 600	2.3	3.7	6.3	11.4	16.4	21.3	27.8
	800	2.0	3.2	5.5	9.8	14.2	18.5	22.8
	1000	1.8	2.9	4.9	8.8	12.7	16.5	20.4
	1200	1.6	2.6	4.5	8.0	11.6	15.1	18.6
$100	$ 600	2.6	4.5	8.0	15.1	22.1	30.2	37.2
	800	2.3	3.9	6.9	13.0	19.1	26.1	32.2
	1000	2.0	3.5	6.2	11.7	17.1	22.5	28.8
	1200	1.8	3.1	5.7	10.6	15.6	20.6	26.3
$200	$ 600	3.1	5.7	10.6	20.6	31.3	41.2	51.9
	800	2.7	4.9	9.2	17.8	27.1	35.6	44.2
	1000	2.4	4.4	8.2	15.9	23.6	31.9	39.5
	1200	2.2	4.0	7.5	14.5	21.5	29.1	36.1
$300	$ 600	3.6	6.7	12.7	25.5	37.6	50.4	62.6
	800	3.1	5.8	11.0	21.5	32.6	43.1	54.2
	1000	2.8	5.1	9.8	19.2	29.1	38.5	47.9
	1200	2.5	4.7	9.0	17.6	26.6	35.2	43.8
$400	$ 600	4.0	7.5	14.5	29.1	43.1	57.7	71.7
	800	3.5	6.5	12.6	25.2	37.3	49.9	62.1
	1000	3.1	5.8	11.2	22.1	33.4	44.2	55.5
	1200	2.8	5.3	10.3	20.2	30.5	40.4	50.7

[a] Maximum combine size is 24 feet. Two or more combines are therefore needed for large acreages of high-value crops.

Other costs

In addition to timeliness costs, only the fixed costs of the machine and operator labor costs need to be considered in selection problems. Costs of fuel, oil, maintenance, and repair are essentially constant for a given acreage regardless of the size or capacity of a machine.

Fixed costs are a function of purchase price which must be expressed in terms of the acreage capacity of the combine. If it is assumed that forward speed and field efficiencies do not vary significantly with size of machine, the machine costs can be developed adequately from only the price per unit of width. Labor costs need be known only on a per-hour basis.

Determining the fixed costs for a self-propelled combine is complex because the combine may be equipped with a cutterbar, a windrow pick-up, and a row crop head for row spacings varying from 20 to 40 inches. Any selection solution must account for the use of any one of the heads

Donnell Hunt is Professor of Agricultural Engineering.

or for a combination of heads used on several different crops during the year.

Using the tables for one crop

The accompanying tables list the estimated optimum size of combine for the variables mentioned. The tables are segregated by type of head and by the price of operator labor. The row crop tables (Tables 3 and 4) are further divided according to row spacing.

If only one head is used on one crop of small acreage, the tables can be used directly. Suppose, for example, that a combine is used in a crop valued at $100 per acre. Purchase price per foot of width is determined to be $600. The annual acreage is 200 acres, which is all ready for harvesting the same day. With a labor cost of $2 an hour, the optimum size of combine would be 8 feet; with $4 an hour, 9 feet. These rather small widths are not generally available and the solutions indicate that most commercially available self-propelled combines would be uneconomic if used only for this acreage. If this 200 acres of grain had been windrowed before combining, the price of the combine would have been expressed in dollars per foot of windrower swath.

For 200 acres of a 30-inch row crop at a price of $3,000 per row, the answers would have been 2.5 rows with labor at $2 per hour and 2.7 rows with labor at $4.

Combines with two heads

Combines using both cutterbar and row crop heads must be sized according to one of the two heads. The tables are entered to find an optimum cutterbar width for the small grain or soybean crops and to find the optimum number of rows for the row crop head. The values are converted to a common basis, squared, and summed; the square root is then extracted to obtain an optimum width considering both heads.

Suppose that a combine is to be used on 50 acres of wheat, 200 acres of soybeans, and 300 acres of corn annually. The whole acreage of each crop will be ready for harvest at one time. Values for the three operations are:

Crop	*Value*	*Combine price*	*Row spacing*	*Labor cost*
Wheat	$100	$800/ft.	....	$2/hr.
Soybeans	$300	$800/ft.	....	$2/hr.
Corn	$200	$5000/row	30 in.	$4/hr.

Using the appropriate tables, we find that the value for wheat is 2.3 feet; soybeans, 11.0 feet; and corn, the average between 2.7 and 5.1 rows or 3.9 rows. For estimation purposes, 1 row can be equated to 4 feet of cutterbar. Thus 3.9 rows would be converted to 15.6 feet. The widths (W) for the three crops are combined as the square root of the sum of the squares:

$$W = \sqrt{W^2_{wheat} + W^2_{soybeans} + W^2_{corn}}$$
$$= \sqrt{2.3^2 + 11^2 + 15.6^2}$$
$$= \sqrt{5.29 + 121 + 243.36}$$
$$= \sqrt{369.69} = 19.2 \text{ ft.}$$

According to these figures, a 5-row combine would be required on a row crop basis.

Table 2. — Optimum Combine Size, in Feet, With Labor at $4 an Hour, Based on Number of Machine Acres, Crop Value, and Purchase Price[a]

Crop value per A.	Purchase price per ft.	50 A.	100 A.	200 A.	400 A.	600 A.	800 A.	1000 A.
		Combine size, feet						
$50	$ 600	3.1	4.7	7.5	12.7	17.8	22.8	30.6
	800	2.6	4.1	6.5	11.0	15.4	19.7	26.5
	1000	2.4	3.6	5.8	9.8	13.8	17.7	21.5
	1200	2.2	3.3	5.3	9.0	12.6	16.1	19.6
$100	$ 600	3.3	5.3	9.0	16.1	23.2	32.3	39.3
	800	2.9	4.6	7.8	14.0	20.1	27.9	34.1
	1000	2.5	4.1	6.9	12.5	17.9	23.4	30.5
	1200	2.3	3.7	6.3	11.4	16.4	21.3	27.8
$200	$ 600	3.7	6.3	11.4	21.3	32.8	42.7	54.2
	800	3.2	5.5	9.8	18.5	28.4	37.0	45.6
	1000	2.9	4.9	8.8	16.5	25.4	33.1	40.8
	1200	2.6	4.5	8.0	15.1	22.1	30.2	37.2
$300	$ 600	4.1	7.2	13.4	26.8	38.9	52.3	64.5
	800	3.6	6.3	11.6	22.1	33.7	44.2	55.8
	1000	3.2	5.6	10.3	19.7	30.1	39.5	49.9
	1200	2.9	5.1	9.4	18.0	27.5	36.1	44.7
$400	$ 600	4.5	8.0	15.1	30.2	44.2	59.3	73.4
	800	3.9	6.9	13.0	26.1	38.3	51.4	63.5
	1000	3.5	6.2	11.7	22.5	34.2	45.1	56.8
	1200	3.1	5.7	10.6	20.6	31.3	41.2	51.9

[a] Maximum combine size is 24 feet. Two or more combines are therefore needed for large acreages of high-value crops.

Two harvest dates

If not all of a crop will be ready at the same time, the procedure is similar to that used when different crops are to be harvested. For example, a combine model priced at $3,000 per row is desired for harvesting 40-inch corn worth $200 an acre. Two varieties and two planting dates suggest that out of a total of 600 acres, 400 will be ready at one time and 200 at another. Labor is at $2 an hour. The number of rows (N) would be:

$$N = \sqrt{N^2_{400} + N^2_{200}}$$
$$= \sqrt{5.5^2 + 2.8^2} = \sqrt{30.25 + 7.84}$$
$$= \sqrt{38.09} = 6.17 \text{ rows}$$

The manager will probably decide on a 6-row combine. Should the 600 acres have been ready to harvest all at one time, the timeliness penalties would have been so great that, according to the table, a combine capacity of 8.4 rows would have been required. This would mean two combines, since six 40-inch rows is the maximum combine size.

Table 3. — Optimum Combine Size, in Number of Rows, With Labor at $2 an Hour, Based on Number of Machine Acres, Crop Value, and Purchase Price[a]

Crop value per A.	Purchase price per row	50 A.			100 A.			200 A.			400 A.			600 A.			800 A.			1000 A.		
		20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows
		Number of rows																				
$50	$3000	.8	.7	.6	1.4	1.1	1.0	2.4	1.9	1.7	4.3	3.5	3.0	6.2	5.0	4.4	8.6	6.6	5.7	10.5	8.6	7.4
	4000	.7	.6	.5	1.2	1.0	.8	2.0	1.7	1.4	3.7	3.0	2.6	5.3	4.4	3.8	7.0	5.7	4.9	9.1	7.0	6.4
	5000	.6	.5	.4	1.1	.9	.7	1.8	1.5	1.3	3.3	2.7	2.3	4.8	3.9	3.4	6.2	5.1	4.4	7.7	6.3	5.4
	6000	.6	.5	.4	1.0	.8	.7	1.7	1.4	1.2	3.0	2.5	2.1	4.4	3.5	3.1	5.7	4.6	4.0	7.0	5.7	5.0
$100	$3000	1.0	.8	.7	1.7	1.4	1.2	3.0	2.5	2.1	5.7	4.6	4.0	8.8	6.8	5.9	11.4	9.3	8.1	14.1	11.5	10.0
	4000	.8	.7	.6	1.4	1.2	1.0	2.6	2.1	1.8	4.9	4.0	3.5	7.2	5.9	5.1	9.9	7.8	7.0	12.2	9.9	8.6
	5000	.7	.6	.5	1.3	1.0	.9	2.3	1.9	1.6	4.4	3.6	3.1	6.5	5.3	4.6	8.8	6.9	6.2	10.9	8.9	7.7
	6000	.7	.5	.5	1.2	.9	.8	2.1	1.7	1.5	4.0	3.3	2.8	5.9	4.8	4.2	7.8	6.3	5.5	9.9	7.9	7.0
$200	$3000	1.2	.9	.8	2.1	1.7	1.5	4.0	3.3	2.8	7.8	6.3	5.5	11.8	9.6	8.4	15.6	12.7	11.0	19.6	15.8	13.9
	4000	1.0	.8	.7	1.8	1.5	1.3	3.5	2.8	2.4	6.7	5.5	4.7	10.2	8.3	7.2	13.5	11.0	9.5	17.0	13.7	11.8
	5000	.9	.7	.6	1.6	1.3	1.1	3.1	2.5	2.2	6.0	4.9	4.2	9.1	7.3	6.5	12.1	9.8	8.5	15.0	12.2	10.6
	6000	.8	.6	.6	1.5	1.2	1.0	2.8	2.3	2.0	5.5	4.5	3.9	8.3	6.6	5.7	11.0	9.0	7.8	13.7	11.1	9.7
$300	$3000	1.3	1.1	.9	2.5	2.0	1.7	4.8	3.9	3.4	9.6	7.7	6.8	14.2	11.6	10.1	19.1	15.4	13.5	23.7	19.3	16.8
	4000	1.1	.9	.8	2.2	1.7	1.5	4.1	3.4	2.9	8.3	6.6	5.7	12.3	10.1	8.7	16.5	13.3	11.5	20.5	16.8	14.5
	5000	1.0	.8	.7	1.9	1.6	1.3	3.7	3.0	2.6	7.3	5.9	5.1	11.0	9.0	7.8	14.6	11.9	10.3	18.3	14.8	13.0
	6000	.9	.7	.6	1.7	1.4	1.2	3.4	2.7	2.4	6.6	5.4	4.7	10.1	8.2	7.1	13.3	10.9	9.4	16.7	13.5	11.7
$400	$3000	1.5	1.2	1.0	2.8	2.3	2.0	5.5	4.5	3.9	11.0	9.0	7.8	16.5	13.3	11.5	21.8	17.8	15.4	27.1	22.2	19.2
	4000	1.3	1.0	.9	2.4	2.0	1.7	4.7	3.9	3.3	9.5	7.6	6.7	14.1	11.5	10.0	18.9	15.3	13.4	23.5	19.2	16.6
	5000	1.1	.9	.8	2.2	1.8	1.5	4.2	3.4	3.0	8.5	6.8	5.9	12.6	10.3	8.9	16.9	13.7	11.8	21.0	17.2	14.9
	6000	1.0	.8	.7	2.0	1.6	1.4	3.9	3.1	2.7	7.6	6.2	5.4	11.5	9.4	8.1	15.3	12.5	10.8	19.2	15.5	13.6

[a] Maximum combine size is eight 20- or 30-inch rows; six 40-inch rows. Two or more combines are therefore required for large acreages of high-value crops.

Table 4. — Optimum Combine Size, in Number of Rows, With Labor at $4 an Hour, Based on Number of Machine Acres, Crop Value, and Purchase Price[a]

Crop value per A.	Purchase price per row	50 A.			100 A.			200 A.			400 A.			600 A.			800 A.			1000 A.		
		20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows	20″ rows	30″ rows	40″ rows
		Number of rows																				
$50	$3000	1.1	.9	.8	1.7	1.4	1.2	2.8	2.3	2.0	4.8	3.9	3.4	6.7	5.5	4.7	9.6	7.0	6.8	11.6	9.4	8.2
	4000	1.0	.8	.7	1.5	1.2	1.1	2.4	2.0	1.7	4.1	3.4	2.9	5.8	4.7	4.1	7.5	6.1	5.3	10.0	7.4	7.1
	5000	.9	.7	.6	1.3	1.1	.9	2.2	1.8	1.5	3.7	3.0	2.6	5.2	4.2	3.7	6.7	5.4	4.7	8.9	6.6	5.7
	6000	.8	.6	.5	1.2	1.0	.8	2.0	1.6	1.4	3.4	2.7	2.4	4.7	3.9	3.3	6.1	5.0	4.3	7.4	6.1	5.2
$100	$3000	1.2	1.0	.8	2.0	1.6	1.4	3.4	2.7	2.4	6.1	5.0	4.3	9.5	7.1	6.7	12.2	10.0	8.6	14.9	12.2	10.5
	4000	1.1	.8	.7	1.7	1.4	1.2	2.9	2.4	2.1	5.3	4.3	3.7	7.6	6.2	5.3	10.6	8.6	7.5	12.9	10.5	9.1
	5000	.9	.8	.6	1.5	1.2	1.1	2.6	2.1	1.8	4.7	3.8	3.3	6.8	5.5	4.8	9.4	7.2	6.7	11.5	9.4	8.1
	6000	.8	.7	.6	1.4	1.1	1.0	2.4	1.9	1.7	4.3	3.5	3.0	6.2	5.0	4.4	8.6	6.6	5.7	10.5	8.6	7.4
$200	$3000	1.4	1.1	1.0	2.4	1.9	1.7	4.3	3.5	3.0	8.6	6.6	5.7	12.4	10.1	8.8	16.7	13.2	11.4	20.5	16.8	14.5
	4000	1.2	1.0	.8	2.0	1.7	1.4	3.7	3.0	2.6	7.0	5.7	4.9	10.7	8.8	7.6	14.0	11.4	9.9	17.8	14.1	12.6
	5000	1.1	.9	.7	1.8	1.5	1.3	3.3	2.7	2.3	6.2	5.1	4.4	9.6	7.5	6.8	12.5	10.2	8.8	15.4	12.6	10.9
	6000	1.0	.8	.7	1.7	1.4	1.2	3.0	2.5	2.1	5.7	4.6	4.0	8.8	6.8	5.9	11.4	9.3	8.1	14.1	11.5	10.0
$300	$3000	1.5	1.2	1.1	2.7	2.2	1.9	5.0	4.1	3.5	10.1	7.9	7.1	14.7	12.0	10.4	19.8	15.8	14.0	24.4	19.9	17.3
	4000	1.3	1.1	.9	2.3	1.9	1.6	4.4	3.5	3.1	8.8	6.8	5.9	12.7	10.4	9.0	17.1	13.7	11.8	21.1	17.3	15.0
	5000	1.2	.9	.8	2.1	1.7	1.5	3.9	3.2	2.7	7.5	6.1	5.3	11.4	9.3	8.1	15.0	12.2	10.6	18.9	15.1	13.4
	6000	1.1	.9	.7	1.9	1.5	1.3	3.5	2.9	2.5	6.8	5.6	4.8	10.4	8.5	7.3	13.7	11.1	9.7	17.2	13.8	12.2
$400	$3000	1.7	1.4	1.2	3.0	2.5	2.1	5.7	4.6	4.0	11.4	9.3	8.1	17.1	13.7	11.8	22.5	18.4	15.9	27.8	22.7	19.7
	4000	1.4	1.2	1.0	2.6	2.1	1.8	4.9	4.0	3.5	9.9	7.8	7.0	14.5	11.8	10.2	19.5	15.6	13.8	24.1	19.6	17.0
	5000	1.3	1.0	.9	2.3	1.9	1.6	4.4	3.6	3.1	8.8	6.9	6.2	13.0	10.6	9.2	17.4	13.9	12.3	21.5	17.6	15.2
	6000	1.2	.9	.8	2.1	1.7	1.5	4.0	3.3	2.8	7.8	6.3	5.5	11.8	9.6	8.4	15.6	12.7	11.0	19.6	15.8	13.9

[a] Maximum combine size is eight 20- or 30-inch rows; six 40-inch rows. Two or more combines are therefore required for large acreages of high-value crops.

FARM BUSINESS TRENDS

Prices of farmland have increased less in Illinois than in most other states since 1960. Even so, land is worth more here than in any other state except for six small states in the densely populated New York-Washington-Boston area.

From 1960 to March 1, 1973, the average acre value of Illinois farm real estate rose 81 percent. Only three states — California, South Dakota, and Minnesota — showed smaller increases. Prices went up 60 percent in California, 76 percent in South Dakota, and 80 percent in Minnesota.

Increases in six other Midwestern states were: Indiana, 90 percent; Iowa, 92 percent; Ohio, 100 percent; Michigan, 108 percent; Wisconsin, 136 percent; and Missouri, 154 percent.

Among the states reporting the greatest increases in land values were Nevada, 275 percent; Georgia, 265 percent; New Jersey, 264 percent; Oregon, 260 percent; West Virginia, 220 percent; Maryland, 213 percent; and Arizona, 204 percent. The average increase for the 48 contiguous states was 120 percent.

There seems to be a pattern to the rates of price increase. The largest percentage increases were mostly in lower priced rural states and in densely populated states.

The rate of increase in land values has greatly accelerated during the past two or three years. From March 1, 1971, to March 1, 1973, prices of Illinois farmland rose 19 percent. Some recent sales of Illinois farms indicate that prices have increased as much as 10 percent just since last winter.

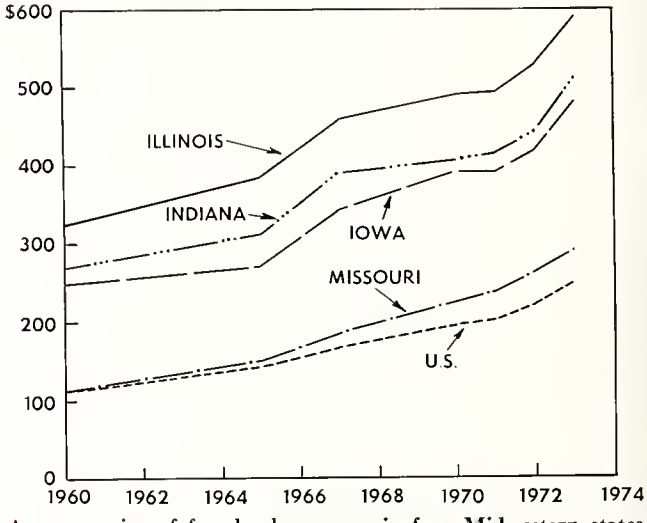
Increases in other Midwestern states from March, 1971, to March 1, 1973, were: Minnesota, 19 percent; Indiana, 20 percent; Ohio, 22 percent; Iowa and Missouri, 24 percent each; Michigan, 30 percent; and Wisconsin, 31 percent. The average 48-state increase was 23 percent.

The average value of Illinois farmland, including improvements, on March 1 was estimated at $590 per acre. (Top-quality land was, of course, much higher — often around $1,000 per acre.) Average prices for land in other Midwestern states were: Indiana, $512; Ohio, $507; Iowa, $482; Michigan, $433; Wisconsin, $336; Missouri, $289; and Minnesota, $275.

Highest average for any state was $1,599, reported by New Jersey. Other states with higher prices than Illinois were Connecticut, $1,316; Rhode Island, $1,036; Massachusetts, $799; Maryland, $888; and Delaware, $663. Lowest prices were $53 in New Mexico, $54 in Wyoming, $76 in Montana, $87 in Nevada, and $93 per acre in Arizona.

Land prices will continue to rise during the foreseeable future, but there may be temporary declines. Major declines, such as those which occurred from 1920 to 1933, are unlikely because of the changes in our monetary system since 1932.

It is often said that farmland is too high because "it will not pay for itself." But neither will most other investments. We do not expect bonds or corporation stocks to pay for themselves; so we should not expect farmland to do so. — *L. H. Simerl, Professor of Agricultural Economics*



Average price of farmland per acre in four Midwestern states and the United States, 1960-1972.

UNIVERSITY OF ILLINOIS · AGRICULTURAL EXPERIMENT STATION
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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Dairy farm on the Urbana-Champaign campus, where much of the research on dairy cattle is conducted. A study of phenobarbital metabolism in the lactating cow is reported on page 5.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 16, Number 1

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

(Cover picture by Elizabeth L. Sully)

Winter, 1974 Volume 16, Number 1

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G. W. Salisbury . . . . . Director

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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DR. ALDRICH TO COORDINATE ENVIRONMENTAL STUDIES

IN A NEWLY created position as Assistant Director of the Agricultural Experiment Station, Dr. Samuel R. Aldrich has assumed the responsibility of coordinating all the environmental studies of the Station.

Dr. Aldrich joined the University of Illinois staff as Professor of Soil Fertility Extension in 1957. Previously, from 1942 to 1957, he had been on the staff of Cornell University. He holds a B.S. degree from Michigan State University and a Ph.D. degree from Ohio State University.

For the past several years, he has been active in investigating environmental problems and also in determining whether charges of pollution brought against agriculture were valid. From August, 1970, to August, 1972, he had a leave of absence from the University to serve on the Illinois Pollution Control Board. While on the board, he developed proposals to be presented at hearings concerning possible restrictions on application of fertilizers and manure. After 10 public hearings, the board decided that no factual basis for regulations existed at the time. Dr. Aldrich wrote the opinion of the board on that matter, as well as in 30 other cases. He also helped to develop the original proposals for the control of livestock wastes, on which public hearings were held in 1973. Hearings on modifications of the original proposals are planned for 1974.

In addition to his work with the Pollution Control Board, he has advised the U.S. Environmental Protection Agency as to proposed regulations on agriculture. He is also a member of a National Academy of Sciences committee that is making a broad assessment of pesticides, including their economic and sociological impact and their effects on food production, the environment, and public health. At the University, he is serving on the Administrative Committee of the Institute for Environmental Studies, as well as the Committee on Interdisciplinary Teaching and Research.

Dr. Aldrich's high degree of competence in environmental studies is built on many years of research and Extension work on soil fertility, minimum tillage, and crop production. He is the co-author of three books and has written more than 70 other publications. Last April he received a Paul A. Funk recognition award for his outstanding contributions to agriculture. — *G. W. Salisbury*

貿易

Trade with China

S. C. SCHMIDT

PRESIDENT NIXON'S visit to the People's Republic of China in February, 1972, marked the end of 22 years of hostility between the United States and China. Since then, the two countries have been engaged in a dialog aimed at opening the doors for trade and cultural relations.

It is possible to think of several good reasons why we should increase trade and cultural exchanges with China, but two may suffice: First, because of sheer size and military strength, China can exercise effective political and economic leverage. Second, trade expansion benefits the economies of both countries and ultimately the welfare of the people.

No predictions can be made with certainty as to the future course of Sino-American trade. It will largely depend on the direction of official policies and the pace of China's economic development. Interrelated with these factors are the bureaucratic impediments inherent in a centrally planned economy.

Basic features of China's trade

The prominent features of China's foreign trade system are (1) centralized planning; (2) arbitrary price and exchange-rate structures; (3) inconvertibility of currency; and (4) reluctance to use long-term credit. All these features contribute to the system's inflexibility and hence have a harmful effect on trade. It should be pointed out, however, that communist foreign trade systems are very flexible when it comes to changing the direction of trade. The dramatically swift reorientation of Sino-Soviet trade in the early 1960's and of Sino-American trade since 1971 are cases in point.

S. C. Schmidt is Professor of Agricultural Marketing.

Centralized planning. The all-inclusive central economic planning encompasses domestic and foreign political goals as well as economic ones. For example, expansion of trade with developing countries, with the purpose of countering Soviet and Western influence, has at times been as important as economics.

In general, however, the foremost function of China's foreign trade is to promote basic agricultural and economic development. Quantities and prices of exports and imports are centrally planned and integrated with this goal.

Planned imports consist of raw materials and capital goods needed to achieve domestic investment and consumption targets. The plans of course have to take into account the availability of foreign exchange and export capacity, as well as obligations under trade agreements.

Export plans are developed on the basis of import plans and anticipated domestic surpluses. Because of the priorities given to agricultural modernization and to industrialization, differences between export and domestic demand are usually resolved in favor of exports.

In spite of all this planning, unexpected shortages in production or planning errors could prevent fulfillment of export commitments or could lead to unplanned imports. Paying for the unplanned imports could, in turn, necessitate the unplanned export of products that may well be scarce at home. On the other hand, exports could provide an outlet for unexpected surpluses.

Price structure and currency. China's price and exchange rate structure does not reflect relative scarcities and costs, and hence has little economic significance. The Chinese currency, called renminbi (or RMB, the People's currency) is largely a domestic currency to date. The basic unit is the yuan, whose value is arbitrarily set with no regard for its real international purchasing power. Its current value, 2.2158 to the dollar, is considered high in relation to Western currencies.

Because of the unrealistic valuation of the yuan, it is unsuitable for inter-country cost comparisons. Chinese planners are unable to determine, on the basis of accounting profits or deficits, the real gains and losses accruing from trade. The present exchange rate structure, therefore, seriously interferes with the development of China's economy on the basis of comparative costs and the international division of labor.

Reluctance to use long-term credit. By trying to balance imports with exports, China seeks to avoid long-term credit. China does, however, use 6- to 18-month commercial credits to buy wheat and fertilizer, and medium-term credits for the purchase of entire industrial plants.

China's aversion to the extensive use of commercial credit is allegedly rooted in the fear that accelerated industrialization financed through foreign credits could set in motion an inflationary spiral that would depreciate the value of money. It is also a manifestation of China's desire for economic independence.

Economic independence

China's unwillingness to become overly dependent on any one country or economic bloc for foreign trade appears to have been shaped by the difficulties of breaking with the Soviet bloc in 1960. By 1971, China got 27 percent of her imports from Japan; 9 percent from Canada; 7 percent from West Germany; 6 percent from France; and 4 percent from the United Kingdom. The principal buyers were: Hong Kong

(18 percent), Japan (13 percent), Singapore (6 percent), West Germany (4 percent), and the United Kingdom (3 percent). At the same time, the developing countries took about 24 percent of China's exports and supplied about 17 percent of its imports. Recently China has revived its trade with other communist countries.

Unlike the Soviet bloc, China aims at balancing its trade account multilaterally. China is applying its large foreign exchange surpluses generated in trade with Hong Kong and a number of developing countries to help finance imports from developed countries. Imbalances in trade with communist countries are settled on a bilateral basis in goods or without the use of hard currencies.

Organizations controlling trade

China's foreign trade is a state monopoly, run by the Ministry of Foreign Trade. Other major elements of China's foreign trade system are seven state foreign trade corporations, the China Council for Promotion of International Trade, and the Bank of China. In addition, there are the Canton Trade Fair, the exhibition of Chinese products in foreign countries, and trade delegations who buy Western products.

The Ministry of Foreign Trade draws up import and export plans and supervises the entire trading process. For example, the Ministry devises trade control and tariff schedules, supervises customs administration, concludes trade agreements and contracts, and issues export and import licenses.

The seven foreign trade corporations, working in close liaison with the Ministry, transact foreign sales and purchases. Each corporation specializes in certain types of goods and services and acts on behalf of both the Ministry and the firms using or producing the traded goods. They function as separate businesses, with authority to negotiate contracts and assume liability for contractual obligations. Together with the Department of Market Research of the Ministry of Foreign Trade and with the commercial attachés at Chinese embassies and consulates, they maintain contact with foreign firms.

There is little interaction between foreign trade corporations and industrial firms or among the foreign trade corporations themselves. As a result, those who plan domestic production may fail to consider foreign market conditions. By the same token, foreign trade corporations may be unaware of the amount and quality of domestic goods available for export. Rigid production plans and low inventories make it very difficult to take advantage of foreign trade opportunities.

The China Council for the Promotion of International Trade is an allegedly independent organization composed of representatives of foreign trade corporations and experts in various fields related to foreign trade. The Council's regular work includes (1) trade promotion; (2) organization of trade fairs; (3) arrangement of appointments with foreign firms and trade delegations; (4) commercial mediation and arbitration of disputes; and (5) registration of foreign trademarks.

The Bank of China is, next to the Ministry of Foreign Trade, the most important controlling agency over the foreign trade corporations. The bank handles foreign exchange, the corporations' international payments, and all other financial transactions with foreign countries.

Trade implications

Overall, China's level of imports is determined by its ability to pay for them and by its policy of balancing exports and imports. Only absolute necessities that are not produced domestically are imported. Priority is usually given to capital goods embodying the latest technology rather than to consumer goods. Thus food grains, sugar, cooking vegetable oils, and cotton cloth continue to be strictly rationed.

U.S. exports to China in fiscal 1972-73 totaled $220.9 million, of which agricultural products accounted for $207.2 million. Cotton contributed about $77.4 million; corn, $64.3 million; wheat, $38.2 million; and vegetable oils, $17.6 million. At the same time our total imports from China were $45.4 million, including some $19.6 million worth of agricultural products.

Given the general austerity of China's economy and its reluctance to purchase on long-term credit, U.S. exports are likely to grow at a slow pace. Any significant gain in U.S. exports to China may even come about at the expense of China's present trading partners. In the absence of foreign credits, China's export capabilities will determine its potential for trade. The export growth rate is estimated to roughly correspond to the 5- to 7-percent growth rate foreseen for the GNP. But the amount of China's future exports depends not only upon economic growth but also upon population increases. Feeding an estimated population of 800 to 850 million, which is growing by 10 to 15 million a year, is a tremendous task.

On present indications, the United States has a good chance of becoming an important supplier of wheat, cotton, vegetable oils, and perhaps tobacco and coarse grains to China. The U.S. Department of Agriculture forecasts that the Chinese will import about 6.5 million tons of wheat in 1973-74, of which the U.S. will supply 4.0 million. The U.S. is also expected to ship about 2.5 million tons of corn to China during the 1974 marketing year. In Chinese nonagricultural markets, the U.S. has some chance to make inroads in chemicals, commercial aircraft, machinery, and equipment.

In view of the indicated obstacles, only a few options are left to facilitate expansion of Sino-American trade. A new basis for trade may be created through direct U.S. investments, joint undertakings, the extension of most-favored nation treatment to Chinese goods, and the initiation of aid programs. But the basic question remains: Is China willing to invite American capital and participate in U.S.-sponsored aid programs?

Phenobarbital Metabolism In the Lactating Dairy Cow

C. L. DAVIS, J. H. CLARK, and B. O. BRODIE

Both beef producers and dairymen suffer losses when cattle are contaminated with chlorinated hydrocarbon pesticides such as dieldrin, heptachlor, and DDT. The beef producer has to delay marketing his animals for meat purposes, while the dairyman loses salable milk.

Since the chlorinated hydrocarbons are fat-soluble, they are concentrated in the fatty tissues of the body and thus are eliminated very slowly. Milk, because of its relatively high fat content, is a major route of elimination from the body of lactating animals.

Phenobarbital recommended

Several studies have been conducted to find ways of speeding up the removal of the pesticide from the contaminated animal. As a result of these studies, the following recommendations have been formulated:

1. Identify and eliminate the source of the pesticide.

2. Feed 2 pounds of activated charcoal per cow per day along with 450 milligrams of phenobarbital per 100 pounds of body weight.

Activated charcoal combines with the pesticide so that it is not absorbed and thus is eliminated through the feces. Phenobarbital accelerates the breakdown of the pesticide in the animal's tissues. Supposedly phenobarbital stimulates liver cells to produce enzymes which alter the chemical form of the pesticide, rendering it water-soluble and therefore easier to remove via the kidneys.

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But the solution of one problem may lead to another. Thus, the feeding of phenobarbital raises several questions: What happens to the phenobarbital in the lactating cow? Does it get into the milk? If so, to what extent and how long after the last dose will it take for the milk to be free of the drug?

Two experiments conducted

In the first of two experiments, two lactating Holstein cows were fed 6 grams of nonradioactive phenobarbital for 10 days. On the tenth day, radioactive phenobarbital was mixed with the nonradioactive material. Total milk, urine, and feces were collected for six consecutive days following the radioactive dose. Radioactive phenobarbital was extracted from each of the excretory products and the amount determined.

The results, which are summarized in Table 1, support several conclusions: (1) Phenobarbital is almost completely absorbed from the gut, as indicated by the small percentage of the drug recovered in the feces. (2) Urine is the main route of elimination from the body, accounting for over 90 percent of the recovered dose. (3) Relatively small amounts of the drug get into the milk, indicating that the mammary gland is highly discriminatory toward phenobarbital.

Calculation of the biological half-life of phenobarbital in milk (the time required for the concentration of the radioactive drug to decrease by one-half) provided an estimate of the time needed for the drug concentration to reach an undetectable level in the milk. This was found to be six days after the last dose.

In the second study, three cows received 6 grams of nonradioactive phenobarbital daily for 10 days. Beginning on the eleventh day, the milk was sampled daily and analyzed for phenobarbital by use of gas-liquid chromatography and ultraviolet spectrophotometry. These methods are commonly used in monitoring biological materials for barbiturates.

Results of this study (Table 2) show that one week after the drug was withdrawn, its concentration in the milk was at an undetectable level.

On the basis of these two studies, we can conclude that, if lactating cows are dosed with phenobarbital in an effort to speed up the removal of pesticides from the body, the drug should be at an undetectable level in the milk within one week after the last dose.

Table 1. — Recoveries and Excretion Rates of Radioactive Phenobarbital After One Dose

	Cow A	Cow 8
Recovery of dose, pct.[a]	68.4	92.2
Pct. of recovered dose in:		
Milk	5.6	3.4
Urine	93.1	94.1
Feces	1.3	2.5
Biological half-life, hr.		
Milk	41.3	39.8
Urine	30.6	28.5
Feces	46.5	46.5

[a] 144 hours after dosing.

Table 2. — Phenobarbital in Milk With Time After Last Dose

Hr. after last dose	Phenobarbital, ppm[a]
48	3.7 ± 0.8
60	1.7 ± 0.8
168 (1 week)	Not detectable by GLC or spectrophotometric determinations

[a] Mean value for three cows ± standard error of mean.

Fescue for The Cow Herd in Southern Illinois

F. C. HINDS,
G. F. CMARIK,
and
G. E. McKIBBEN

MUCH of southern Illinois is ideally suited for grazing beef cattle. The natural advantages of a long grazing season and a favorable rainfall distribution are enhanced by the general use of high-producing forage.

Probably the most common forage grass in the area is tall fescue. It is persistent, has a high tolerance to various levels of soil fertility, and is adaptable to various management systems.

Forage quality low in summer

Tall fescue produces large amounts of high-quality feed both early and late in the grazing season. Unless it is properly managed, however, the plant material available during the middle of the season is of rather low quality. This drop in quality is characteristic of all cool-season grasses, but it usually occurs earlier in the year in fescue than in other grasses.

The change in quality is directly related to the growth stage of the fescue plants in the pasture. Although influenced slightly by fertility, the stage of growth is largely dependent on day length and on environmental temperature.

Quality changes fast

In the spring, the soil usually contains enough reserve moisture and nutrients to permit rapid production of dry matter. As soon as the temperature warms up enough, fescue growth rapidly accelerates.

At first — during the vegetative stage in early April — forage quality is high. However, as days lengthen, the rapid growth of the fescue quickens the pace of the normal change in plant composition. As a result, quality plummets, dropping from about 70 percent digestible dry matter in April to 40 percent or less digestible in late May or early June, when the plants reach the seed stage.

Because cool-season grasses are dormant during the warmer part of the growing season (June-August), digestibility of the forage does not improve, and may even decline further, until the end of summer. At that time fescue and other cool-season grasses emerge from their dormancy and begin a new period of vegetative growth. Since day length is declining and environmental temperature is dropping, the plants remain vegetative through the fall. Plant material is thus of much higher quality than in the summer, although the quantity of forage produced is not high.

Energy is low

As the percentage of digestible dry matter goes down, the levels of most nutrients also decline. Except for rare cases, however, the most critical drop is in digestible energy. In several years' grazing studies with cool-season grasses at the Dixon Springs Agricultural Center, it was found that supplemental energy improves animal performance more than do supplemental vitamins, minerals, or protein.

Unfortunately, the forage is low in digestible energy at just the time when the spring-calving cow has especially high energy needs. It can thus be easily seen that, unless the quality of mid-season fescue pastures is improved, both the weaning weights of calves and the conception rates of cows will be reduced.

Ways of improving quality

Improving the quality of mid-season fescue pastures can be approached in at least three ways:

1. Management of the stands can be aimed at having the plants in a vegetative stage of growth between May and August. This will require careful management of animals as well as clipping of the pastures.

2. Legumes can be incorporated into the fescue pasture. By providing high-quality material for grazing from May to September, legumes would compensate for the low quality of the fescue in midseason.

3. Management and legumes can be combined to improve pasture quality.

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Fescue pasture under split management. Hay has been harvested as round bales, which are to be picked up and stockpiled outside the pasture. Unless legumes were seeded with the fescue, cows did not perform as well under the split management system as under a system of continuous grazing.

Management and pastures studied

In a recent three-year study at Dixon Springs, two management systems were used on 15-acre fescue and legume-fescue pastures. The legumes were a mixture of alfalfa, red clover, and lespedeza. Experimental treatments were replicated.

In the first management system the pastures were continuously grazed from mid-April to late October. In the second (split management) system, half, or 7.5 acres, of the pasture was grazed for the same period while the other half was grazed only after hay was harvested as round bales in early June.

Stocking rate varied from 1 to 1¼ acres per cow. During the three years, a total of 39 cows and their calves were grazed on each 15-acre pasture. One mature bull was turned into each pasture during the breeding season (May through July).

At roundup in early November, the cows were checked for pregnancy, and the calves' weaning weights and grades were obtained. None of the calves had received creep feed.

Differences in performance

As shown in the table, including legumes in a fescue stand increased calf weaning weight, grade of calves at weaning time, and conception rate of cows.

Performance of Cows and Calves on Fescue or Legume-Fescue Pastures Under Two Management Systems[a]

Measurement	Management	
	Split	Cantinuous
Fescue pasture		
Adjusted 205-day wt., lb.	305	325
Calf grade at weaning	High gaad	High gaad
Cow conception rate, pct.	75	85
Legume-fescue posture		
Adjusted 205-day wt., lb.	357	347
Calf grade at weaning	Law choice	Law choice
Cow conception rate, pct.	89	86

[a] Each value represents the mean of 68 observotions collected over three seasons.

System of management had only a minor and inconsistent influence on cattle on the legume-fescue pastures. However, on the fescue pastures, continuous grazing resulted in a higher level of performance than did split management. This result was not anticipated, but it occurred consistently in each of the three years. Probably the continuous grazing kept the fescue plants in a more vegetative stage of growth than normal.

In the split management system, which required harvesting of hay, the legume-fescue pasture did not produce enough forage for grazing during the latter part of the season. As a result, the cattle consumed almost all of the harvested hay. Cattle on the fescue pasture used little, if any, of the harvested forage. This suggests that, although legume-fescue pastures produce no more or even less dry matter than the fescue pastures, the legume-fescue dry matter has greater nutritive value, which is accompanied by increased forage intake.

The calves produced by cows grazing fescue not only weighed less and graded lower than the other calves, but also had the characteristic appearance of a "fescue-calf." A fescue-calf will generally be lighter than it looks, will have a rough hair coat, and will be slightly less alert than a normal calf.

Need for legumes is indicated

The sizable differences in performance between cows and calves on the fescue pastures and those on the legume-fescue pastures clearly indicate that cow-calf operators need to incorporate legumes into their fescue stands if maximum performance is desired.

It is likely that the superior performance of cattle on the legume-fescue pasture is related to the greater amount of digestible energy provided by the legumes in mid-season. The differences in cow conception rates suggest that the fescue pasture does not provide enough energy during the breeding season. A more general lack of energy, which may not be related to any specific time, is indicated by the differences in calves' weaning weight and grade.

Further studies now being conducted are designed to determine whether performance can be improved on fescue pasture by using supplemental sources of energy.

Water Costs for Farms In the Claypan Area

C. L. MOORE

Illinois has an abundant water supply. In a year of good rainfall, the amount of available water may be three times greater than the amount actually used. However, the supply is unevenly distributed throughout the state, and some areas are often short of water. One of these is the claypan area of southern Illinois.

Farmers in the claypan area, especially in Washington County, have had problems stemming not only from water shortages but also from poor water quality. In 1970 there were reports that baby pig losses and breeding problems in some dairy herds were likely due to the high nitrate content of the county's drinking water.

As a result, many farmers and rural residents in the area began examining various alternatives to their current water supply. The situation on 38 farms in northeastern Washington County has served as a basis for an economic evaluation of alternative farm water sources in the claypan area of southern Illinois.

Water needs and sources

Nearly all of the 38 households in the study area used two or more water sources to meet their daily requirements. The few that used only one source had little or no livestock, so that they needed water mostly for household use.

To determine just how much water was needed by the 38 families, each one was asked about the number of persons in the household, the maximum number of livestock on the farm at any one time, and the farm's uses of water. On the basis of the responses to the questions, the residents were divided into three categories.

The first category consisted of families who needed water primarily for household use and who thus had to have water fit for human consumption (referred to as quality I water). These families were designated as "rural residents."

The second category included farmers who milked more than 25 dairy cows. This group was designated "primarily dairy." Farmers in this category needed quality I water not only for their households, but also for their milkhouses. They also needed large amounts of quality II water (water suitable for uses other than human consumption) to water their livestock.

The third category consisted of farmers who needed quality I water only for household use, but who had a great demand for quality II water for livestock. This category was designated "general livestock." Table 1 shows average daily water requirements for each category.

The primary sources of water in the study area were (1) shallow wells, less than 30 feet deep, with a large diameter, (2) cisterns, (3) ponds, and (4) water hauled from a nearby village. Hauling water was obviously done to meet the deficit in on-the-farm supplies. Periods of little or no rainfall occur so frequently that several farmers in the study area owned water-hauling equipment. The farmers who were doing most of the hauling were those with sizable dairy operations, for U.S. Public Health standards require that water used in the milkhouse must be fit for human consumption. Much of the water in the area did not meet this requirement.

To estimate the quality of water supplied by on-the-farm sources, samples from as many sources as possible were sent for analysis to the Regional Diagnostic Laboratory in Centralia. Tests previously made by the Department of Agricultural Engineering provided supplemental information.

All the cisterns and ponds tested were free of nitrate contamination. However, as shown in Table 2, 77 percent of the shallow wells in the area contained more than 45 parts per million of nitrate, which is the upper limit that the U.S. Public Health Department recommends for drinking water. Nitrate levels for wells in the study area closely approximated levels found in the county as a whole (Table 2).

When water from wells and cisterns was tested for coliform bacteria, only one of the wells and none of the cisterns contained water that was safe for human consumption.

Alternative water sources

Six alternative water sources were compared on the basis of costs associated with each source over a period of 40 years. The projected costs were discounted to present values. The six alternatives are:

1. Present on-farm sources. Costs would include the cost of replacing present sources with new sources of the same type and capacity. In addition, there are operation and maintenance costs, plus the costs of replacing sources that will not last 40 years.

2. Pond with treatment. The cost of a pond large enough to furnish all the water needs of a family was estimated. In addition to the cost of the pond and spillway construction, we had to include the cost outlays for a treatment system that would purify the water necessary to meet

C. L. Maare was formerly Research Assistant, Department af Agricultural Ecanamics. Research reparted in this article was partly funded by the U.S. Department af the Interiar as autharized under the Water Resaurces Research Act af 1964, P.L. 88-379, Agreement Na. 14-31-001.

Table 1. — Water Requirements of Three Categories of Farmers for Quality I and Quality II Water

Category of farmer	Mean gal./day	Range, gal./day
	Quality I water	
Rural resident	150	50-300
Primarily dairy	1,165	600-2,500
General livestock	240	100-625
	Quality II water	
Rural resident	13	0-90
Primarily dairy	1,722	900-3,500
General livestock	1,492	60-7,400

quality I uses. Investments for replacement would be incurred at various times during the 40 years.

3. Present on-farm sources plus the hauling of quality I water. This alternative included the costs of the present sources used to supply quality II water, plus the costs of hauling from the nearby village all the water required to meet quality I needs.

4. Hauling all water. Costs for this alternative were calculated to show just how expensive it would be to haul all water during a long drouth.

5. Municipal line, both quality I and II water. Estimates were made of the construction, operating, and maintenance costs for a pipeline which would be connected to the water system of a nearby village. In addition to these costs, the variable costs of the water used were included.

6. Present on-farm sources, with municipal line for quality I water. This alternative included the costs of the present sources used to supply quality II water (as in alternative 3), plus the costs of a pipeline system connected to the village system to furnish the quality I water.

Sources ranked

The relative costs of the six alternative water sources, in terms of present values, are given in Table 3. The alternatives are also ranked both as to cost and reliability. The reliability ranking was arrived at by considering the systems' dependence upon the rainfall in the area. Present sources alone are the least reliable because shallow wells and cisterns need rainfall for recharge.

The second alternative, ponds with treatment, is somewhat more reliable. Ponds, because of their design and storage capacity, are better insulated against short-term drouths than are wells and cisterns. However, long-lasting drouths would still cause ponds to fall short of supplying the desired water.

The remaining four alternatives all have a ranking of one because some or all of the water comes from a source that is not so closely dependent upon the monthly rainfall. If on-the-farm sources "go dry," the deficit could be made up by more water from the off-the-farm source.

Which is best?

Although the continued use of present sources may be the least-cost alternative, the unreliability and poor quality of these sources make them undesirable. The choice should therefore be made from the remaining five alternatives.

A pond with water-treatment system could be a very satisfactory source. However, with a prolonged drouth, this source might become unreliable, and the high cost of hauling would have to be incurred to make up the deficit. Further, some farmers object to drinking pond water. If alternative six were chosen, and a drouth were to occur, the deficit could be made up conveniently by using additional water from the existing municipal water line. In effect, the municipal line would be insurance to cover the occurrence of a drouth.

Table 2. — Shallow Well Nitrate Levels in Study Area and in Washington County

Range of NO_3, ppm	Study area		Washington County[a]	
	No. of wells	Pct.	No. of wells	Pct.
0	4	11.42	33	15.49
1-45	4	11.42	24	11.27
46-100	2	5.71	21	9.86
101-150	5	14.2	46	21.60
151-200	7	20.00	16	7.51
201-250	2	5.71	23	10.80
251-300	3	8.57	20	9.39
301-350	4	11.42	7	3.29
351-400	3	8.57	7	3.29
401-450	0	0.00	8	3.76
451-over	1	2.85	8	3.76
Total	35		213	

[a] From a county-wide water survey conducted by W. D. Smith, R. O. Hill, and W. H. Walker in 1970.

When the graduated rate schedule is examined in conjunction with the relative reliability of the sources, alternative six appears to be the best choice for the total area. However, with the flat rate schedule, the choice is more difficult. For the entire area, the pond-with-treatment method would be somewhat less expensive than the municipal system, but it would also be less reliable. Certainly, dollar costs are not the only consideration: reliability and quality must also be considered, especially as the latter affects health.

Table 3. — Total Costs, Based on Present Values, of Six Water Sources for 38 Farms Over 40 Years, Plus Cost and Reliability Ratings

System	Cost	Cost ranking[a]		Reliability ranking[b]
		Flat rate	Graduated rate	
Present sources	$ 216,434	1	1	3
Pond with treatment	333,148	2	4	2
Present sources, haul quality I	476,834	4	5	1
Haul all water	1,158,758	6	6	1
Municipal line, all water				
Flat rate per 1,000 gal.	498,257	5	..	1
Graduated rate	247,928	..	3	1
Present sources, municipal line for quality I				
Flat rate per 1,000 gal.	381,717	3	..	1
Graduated rate	247,098	..	2	1

[a] Cost rankings are based both on a flat rate per 1,000 gallons of municipal water and on a graduated rate (a rate varying with quantity of water used). 1 = best; 6 = poorest in terms of cost.
[b] 1 = best; 3 = poorest, in terms of reliability.

Nitrogen on Soybeans: Does It Help?

L. F. WELCH

BECAUSE SOYBEANS are a legume, they can symbiotically fix nitrogen from the air surrounding the roots. Even so, farmers often ask whether soybean yields can be increased by adding nitrogen fertilizer.

As far as we can tell at present, nitrogen fertilizer does not bring bigger soybean yields in Illinois. This conclusion is based on the results of studies conducted at 10 locations throughout the state (see map).

Residual nitrogen

Generally, Illinois growers do not add much fertilizer N directly to soybeans. However, soils where soybeans are grown may contain a great deal of residual N fertilizer as the result of applications made to previous crops. Corn and soybeans are grown in alternate years on a large acreage, and corn usually receives a direct application of nitrogen.

Locations of plots where trials were conducted.

Table 1. — Soybean Yields at Four Locations as Affected by N Applied to Corn the Preceding Year

N to corn, lb./A.	Soybean yield, bu./A.				
	Aledo	Dixon	Elwood	Kewanee	Av.
0	48	40	37	40	41
80	49	40	36	38	41
160	48	39	36	40	41
240	48	42	36	40	41
320	48	42	36	37	41

Two studies were conducted to determine whether soybean yields are affected by residual N fertilizer. In one four-year study, five rates of N were applied to corn in a corn-soybean cropping system at four locations (Table 1). The nitrogen was broadcast and disked in before planting corn. Thus, soybeans were planted 13 months after the fertilizer was applied.

The second study was conducted at four other locations (Table 2). This study differed from the first one, not only in location, but also in rates of nitrogen tried or cropping system (or both). A corn-soybean-wheat cropping system was followed at Brownstown, with 50 percent as much N applied for wheat as for corn. At Carthage the cropping system was corn-corn-soybeans; each corn crop received the amount of nitrogen indicated in Table 2. A corn-soybeans cropping system was followed at both Hartsburg and Toledo.

Nitrogen added to preceding nonleguminous crops did not affect soybean yields at any of the locations (Tables 1 and 2), although large amounts of nitrogen should have remained on the high-fertilizer plots. Even in years favorable for high corn yields, no more than about 160 pounds of nitrogen per acre was removed from the field in harvested corn grain.

Past research has shown that high

Table 2. — Soybean Yields at Four Locations as Affected by N Applied to Nonleguminous Crops in the Cropping System

N to corn, lb./A.	Soybean yield, bu./A.				
	Browns-town	Car-thage	Harts-burg	Toledo	Av.
0	30	49	44	36	40
60	30	47	44	38	40
120	32	48	44	38	40
180	31	47	42	36	39
240	31	49	44	39	41

L. F. Welch is Professor of Soil Fertility. In addition to Professor Welch, the following present and former members of the Department of Agronomy contributed to the research reported in this article: L. V. Boone, C. G. Chambliss, A. T. Christiansen, D. L. Mulvaney, M. G. Oldham, and J. W. Pendleton.

Table 3. — Soybean Yields at Aledo as Affected by Manure Added for Corn

Manure, T./A.[a]	Yield, bu./A.	Manure, T./A.[a]	Yield, bu./A.
0	49	20	49
5	48	40	48
10	50	80	48

[a] These rates were applied for corn five times during a seven-year period.

Table 4. — Yields of Continuous Soybeans With Rates of Added N at Hartsburg

N added, lb./A./year	Soybean yield, bu./A.	
	1968-'71	1954-'71
0	47	37
40	46	36
120	47	37

Table 5. — Soybean Yields as Affected by N and Planting Date at DeKalb

N added, lb./A.	Planting date			
	May 10	May 18	May 27	June 5
	bushels per acre			
0	51	48	48	51
40	51	51	47	51
80	51	50	48	49

fertilizer N in the soil reduces the amount of nitrogen symbiotically fixed by the soybeans. This phenomenon has been used to explain why soybeans have not usually responded to fertilizer N. In this study, however, the inorganic forms of residual N should have been primarily below the plow depths and thus should not have reduced nodule development — at least not early in the season.

When soybeans follow corn in a cropping system, it appears unwise to reason that any N fertilizer not used by corn would benefit the soybean crop. The same thing is true if nitrogen is applied in the form of manure, as indicated by an experiment conducted at Aledo.

In this experiment, corn was grown for seven consecutive years and several rates of cattle manure were applied every year. The eighth year, soybeans were grown without additional manure. The residual manure left in the soil represented a slowly available source of nitrogen that would be mineralized throughout the growing season. Even so, the residual manure did not affect soybean yields (Table 3).

Table 6. — Soybean Yields at Urbana as Affected by Time and Rate of Sidedressed N

Time of applicotion	N, lb./A.	Yield, bu./A.
June 20 (Early flowering)	0	46
	100	45
	200	48
July 12 (Pod filling)	0	46
	100	46
	200	47

Direct nitrogen

Several experiments have been conducted through the years to determine whether soybean yields are increased by various rates and methods of direct N application.

Continuous soybeans. Soybeans have been grown continuously on the same plots for 18 years at Hartsburg. Fertilizer N has been broadcast and disked in shortly before planting each year. In addition to 18-year average yields, Table 4 gives averages for a recent four-year period, when yields were considerably higher. Fertilizer N did not increase yields.

Planting dates and N rates. Three rates of N were added to soybeans planted on four dates at DeKalb. Neither nitrogen nor planting date affected yields (Table 5).

Sidedressed N. Earlier studies have shown that the number of nodules decreases as available soil nitrogen increases. It was reasoned that, if N application were delayed, perhaps nodules would become established and remain effective even after the addition of N fertilizer. However, soybean yields were not affected by N applied either at early flowering or at pod filling (Table 6).

Plow-down and disked-in N. The effects of N applied in November just before plowing were compared with the effects of N broadcast in April followed by disking. Neither plow-down nor disked-in N increased soybean yields (Table 7).

Table 7. — Soybean Yields at Urbana With Plow-down and Disked-in Rates of N

N added, lb./A.	Soybean yield, bu./A.	
	Plow-down N	Disked-in N
0	57	54
75	56	51
150	55	55
300	55	57

Table 8. — Soybean Yields at Urbana With High Rates of N

N, lb./A.			Soybean yield, bu./A.		
1968	1969	1970	1968	1969	1970
0	0	0	54	53	40
40	200	200	54	57	41
80	400	400	56	57	45
120	800	800	53	55	42
160	1600	1600	54	34	36

High rates of N. In 1968 a study was started at Urbana with moderate rates of N. Rates were increased in 1969 so that the high rates could furnish more than the total nitrogen needs of soybeans. The nitrogen was applied in the form of ammonium nitrate broadcast in the spring. It was disked in for the first two years and plowed down in 1970.

Yields were not affected by N in 1968 (Table 8). In 1969 and 1970, yield was reduced on plots receiving 1600 pounds of N per acre; the high N rate caused a loss of stand and overall stuntedness of the plants. The strongest tendency toward a yield increase occurred in 1969 and 1970 with 400 pounds of N an acre. However, applying this much N would be unprofitable at present prices.

Other studies

Occasional studies in Illinois may have indicated an apparent soybean yield increase due to N fertilization. These occasions have been rare as compared to the cases where yields were not increased. More studies are being conducted to determine whether fertilizer N might increase soybean yields in certain situations.

Antibacterial Drugs in Livestock Feed And Drug-Resistant Organisms in Humans

W. G. HUBER and D. SIEGEL

TREATMENT of human as well as animal disease may be affected by the widespread use of antibacterial drugs in livestock and poultry feed.

This use of the antibacterial drugs in feed was described in a recent issue of ILLINOIS RESEARCH (Summer, 1973). Also discussed were the effects on an animal's Gram negative enteric bacteria.

Bacteria become resistant

The Gram negative enteric bacteria are a large group of similar types of bacteria that live in the intestines of man and animals. Most of these organisms are normal inhabitants of the intestine and usually are not pathogenic. Others, however, do cause disease. The problem when antibacterial drugs are fed regularly is that the Gram negative enteric bacteria develop resistance to them.

In farm animals raised on feeds containing these drugs, nearly all the Gram negative enteric bacteria were found to be resistant, in contrast to an almost complete absence of resistance in the organisms of animals with minimal or no exposure to the drugs.

Unfortunately, resistance is not usually just to a single drug — multiple drug resistance is a general rule. Furthermore, multiple resistance can spread infectiously from a resistant organism to previously sensitive organisms. This phenomenon is known as transmissible or infectious drug resistance. It is mediated by a genetic entity called an R factor.

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Since the great majority of the resident Gram negative enteric organisms of the intestine do not cause disease, their resistance to antibacterial drugs might not be considered of any consequence. However, because the resistance is transmissible, it can be passed on to drug-sensitive pathogens.

The likelihood of a pathogen's becoming multiply drug-resistant, and the speed with which it does so, may be related to the number of its contacts with resistant bacteria, as well as to the degree of its exposure to antibacterial drugs. By contacting resistant organisms in animals raised on drug-supplemented feeds, a pathogen may become resistant to the very drugs that are used to treat the disease it causes.

Obviously, the nontherapeutic use of antibacterial drugs in feed may make it difficult to treat animal diseases. An additional cause for concern is the possibility that resistant organisms may be transferred from the farm to the consumer in his food. If resistant bacteria can establish themselves in the flora of the consumer, they may act as a reservoir of drug resistance for organisms that produce human diseases.

Five groups studied

How likely is it that organisms originating on the farm will become residents of the flora in the human consumer? To gain some insight into this question, the proportions of drug-resistant organisms in fecal specimens from five groups of people were determined by a procedure described in the previous ILLINOIS RESEARCH article. The groups were:

Group 1 — 21 persons who had not received any antibacterial drugs for medical purposes within the prior 6 or more months, but who took care of farm animals (mainly swine) raised on feed containing such drugs.

Group 2 — 10 persons who lived on a farm where antibacterial drugs were used in feed, but who rarely had contact with the livestock and who had not received antibacterial drugs for at least 6 months.

Group 3 — 12 persons who had received an antibacterial drug within the prior 2 weeks but who had no contact with farm animals.

Group 4 — 32 persons who had no contacts with farm animals and had not taken an antibacterial drug within the prior 6 months, but who resided in a household with a person who had recently received such a drug.

Group 5 — 31 persons who had no contact with farm animals, had not received antibacterial drugs for 6 or more months, and did not reside with people who had taken the drugs.

We reasoned that relatively few resistant organisms should show up in samples from persons in Group 5. The enteric florae of these individuals had not had the selective pressures of treatment with an antibacterial drug. Nor had they had many opportunities for exposure to the drug-resistant organisms of treated individuals or of farm animals fed antibacterial drugs.

On the other hand, samples from Group 3 — individuals recently treated with an antibacterial drug — should contain a much larger proportion of drug-resistant organisms than samples from Group 5. Samples from the other three groups, who were exposed in one way or another

to people or animals that had recently consumed antibacterial drugs, would also be expected to contain more resistant organisms than the Group 5 samples.

Variations between groups

As shown in the table, the results for Group 5 were as expected. Few of these people, with no known exposure to antibacterial drugs, farm animals, or drug-treated individuals, had high proportions of resistant organisms in their resident flora. For example, in only 13 percent of the Group 5 samples were more than 1 out of 10 organisms resistant to oxytetracycline. On the other hand, 43 percent of the samples contained less than 1 oxytetracycline-resistant organism out of 10,000 organisms.

Compared with Group 5, a much larger percentage (58 percent) of samples from persons recently treated with antibacterial drugs, or Group 3, contained more than 1 out of 10 oxytetracycline-resistant organisms. Only 8 percent contained less than 1 resistant organism out of 10,000.

Group 4 individuals, those residing with a person who had recently received an antibacterial drug, were intermediate between Groups 3 and 5 in percentages of samples with high or low proportions of resistant organisms.

High percentages of samples from Groups 1 and 2 — people having direct or indirect contact with farm animals — contained large proportions of resistant organisms. In Group 1, 68 percent of the samples contained at least 1 out of 10 organisms that was resistant to oxytetracycline, while only 10 percent of the samples contained less than 1 resistant organism out of 10,000. Very similar results were obtained with Group 2 samples.

It is apparent from the table that resistance to dihydrostreptomycin follows the same pattern among the different groups as resistance to oxytetracycline.

Persons living on farms (Groups 1 and 2) did not appear to have as high percentages of resistant organisms as did the farm animals themselves (see previous article). However, these groups had about the same proportions of resistant organisms as did people recently treated with antibacterial drugs.

In considering the results for people living and working on farms (Groups 1 and 2), there is a question as to the source of drug-resistant organisms. It is possible that farm people inadvertently ingested some of the antibacterial drugs, and that these drugs acted directly on the human Gram negative enteric bacteria to make them resistant.

However, this possibility is not very likely, although no experimental method was available to eliminate it entirely. The farm residents in Group 2 had little or no direct contact with the animals, much less with the antibacterial drugs in the feeds. In any case, the ingestion of antibacterial drugs from feed should be negligible, even for people directly concerned with animal care. It therefore seems reasonable to conclude that the major cause for the high proportions of resistant organisms in the samples from farm residents is the continuing contact of these persons, either directly or indirectly, with the resident flora of the farm animals.

This conclusion is supported by a comparison of Groups 3, 4, and 5. Samples from Group 4 (persons not treated with antibacterial drugs but living with individuals who had been treated) had smaller proportions of resistant bacteria than did the samples of treated individuals (Group 3). But the Group 4 samples had higher proportions of resistant bacteria than the samples from Group 5 individuals — those with no treatment and no exposure to treated persons or to farm animals.

The results thus suggest that a person's mere contact, direct or indirect, with large proportions of resistant Gram negative organisms can substantially increase the drug-resistant organisms in his resident flora. Evidently, the cross-over of bacteria between man and animal is quite feasible. These results are consistent with, although they do not prove, the supposition that organisms originating on the farm may become part of the flora of the consumer of the farm product.

Studies now being conducted in our laboratory and elsewhere will, it is hoped, yield more direct information on these problems.

Distribution of Fecal Samples From Groups of Humans With Varied Exposure to Antibiotics, According to Proportions of Gram Negative Enteric Microflora Resistant to Two Antibacterial Drugs

Drug and group of people[a]	Proportions of resistant organisms[b]				
	10/10 to 1/10	1/10 to 1/100	1/100 to 1/1,000	1/1,000 to 1/10,000	Less than 1/10,000
	percentage of samples				
Oxytetrocycline					
Group 1	68	5	12	5	10
Group 2	70	20	0	10	0
Group 3	58	25	0	8	8
Group 4	22	25	6	12	33
Group 5	13	19	13	13	43
Dihydrostreptomycin					
Group 1	53	14	14	14	5
Group 2	50	0	30	10	10
Group 3	67	0	0	8	25
Group 4	13	30	10	7	36
Group 5	11	18	7	11	54

[a] *Group 1:* Persons having direct contact with animals raised on antibacterial drug-supplemented feed. *Group 2:* Persons residing on farm with Group 1, but having no direct exposure to animals. *Group 3:* Persons recently treated with antibacterial drugs but not exposed to farm animals. *Group 4:* Persons residing in household with Group 3, but not receiving any treatment with antibacterial drugs. *Group 5:* Persons with no exposure to antibacterial drugs or farm animals.

[b] Figures indicate only the proportions that were resistant and do not suggest the numbers of organisms tested for resistance. More than 100,000 organisms were tested from each sample. 10/10 means that all organisms tested were resistant; 1/10, one out of every 10 organisms tested was resistant, etc.

Machinery Costs on Corporation Farms and Family Farms

DONNELL HUNT

One of the advantages given for expanding family farms into larger units is the expected reduction in machinery system costs.

This reduction, it is argued, could come in three ways: (1) Machines can be utilized more in a large operation. Although this might shorten their useful life, cost per acre or hour would be less than for the longer lived, less used machines on smaller farms. (2) A large farm can economically support a sizable service shop operated by a skilled mechanic, thus keeping down repair and depreciation costs. (3) Large farms can buy machines and parts at substantial discounts.

A contrary opinion is that machine system costs would be lower on a family farm because the operator would use more care in operating machinery and would be more attentive to service needs.

In a 7-year study, machinery use and costs on a large corporation farm were compared with those for 46 family farms. The corporation farm, located in central Illinois, comprises 9,000 acres of cropland that is mostly river bottom with mixed heavy clays, loams, and sands. Its principal crop is corn for grain and silage. Major machinery repairs can be done in a large farm shop.

The family farms, all in east-central Illinois, average about 500 acres of cropland. Most of the acreage is about equally divided between soybeans and corn, with small acreages in wheat, hay, and other crops. Implement repair and minor tractor repair are mostly done on the farm. Major overhauls are usually performed by a local dealer.

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Machine use and replacement

Many machines on the corporation farm were used 2 to 7 times as much as those on the average family farm (Table 1). However, tractor hours and grain drill and corn planter acreages were only about 1.8 times as great. Since these machines were about the same size on all the farms, the large farm could achieve no greater individual machine capacity than could the family farms. Instead, the greater use meant longer time in the fields. But operations such as seeding grain and planting corn must be done within a rather short time for optimum results, and both types of farms tended to use their seeding machines for all the working time available. Tractors, too, were generally used only as the need for timely field work permitted.

Average accumulated usages (average age multiplied by average annual use) for disks, row cultivators, rotary hoes, and grain drills on the family farms approached those on the corporation farm. For corn planters and field cultivators, family farms exceeded the corporation farm in average accumulated usages.

Average age of equipment was 3.5 years less for the corporation farm. Planters were traded every 2 years, tractors every 3 or 4 years. Similar short-term ownership was planned for other high-use equipment. Family farm operators followed widely varying replacement policies.

Repair rates

Actual repair rates are expected to be quite variable within any group of similar machines. Wear occurs directly with use, but the rate of wear may depend on the degree of lubrication and maintenance.

The cost of repair due to wear is delayed until the worn part is replaced. This in turn depends on the operator's evaluation of how long a worn part can function adequately. Repairs due to accidents and part breakages cannot be anticipated. Only the mean values from many observations yield data with any validity, and then only as probabilities.

The *mean* value for a group of repair rates is a sound statistical figure that gains additional meaning if accompanied by some measure of variation. The *range* gives the highest and lowest rates observed, but often these are extreme values that rarely occur. The *standard deviation,* s, defines a range of values in which nearly 70 percent of all the data can be found. Numerically this range extends from the mean minus one standard deviation to the mean plus one standard deviation. For example, about 70 percent of the repair rates for corporation tractors fell in the range of 18 (39 − 21) to 60 (39 + 21) cents an hour.

In Table 1 the s value is often greater than the mean. Since negative repair rates are impossible, the inference is that the distributions are not normal and that many repair rates are much greater than one standard deviation above the mean.

As indicated by the s values, repair rates are more variable on the family farms than on the corporation farm. The large farm had a more constant use factor and a more regular repair schedule.

For family farms, repair costs included the cost of parts and off-farm labor. A charge for owner-operator time to install parts or do maintenance was not included. For the corporation farm, shop labor to do seasonal renovation and overhaul was included, but not the labor of repairing field breakdowns.

The family farms achieved the lower average repair rate for disk harrows, field cultivators, corn planters, grain drills, row cultivators, and rotary hoes. (In some instances, how-

ever, the few machine-years for which records were available do not justify forming firm conclusions.) These are all soil-working implements, and it is probable that the corporation farm soil conditions caused greater repair costs than did the silt loams typical of the family farms.

Repair rates for moldboard plows were similar for each type of farm. The draft for plowing was high on the corporation farm, with two tractors being used in tandem to pull a 6-16 plow. Even so, abrasive wear apparently was not excessive. However, clods formed after wet plowing would impose very heavy loads on secondary tillage machines and seeders, accounting for their high repair costs.

The corporation farm had a clear repair rate advantage for the remaining machines. Tractors, combines, and forage harvesters, all of which can have a sizable annual repair cost, were especially low. Even without the estimated 20 percent discount for parts, the corporation farm rates would still be below those for the family farm. One can speculate that the increased annual use, the short ownership period, and the superior repair facility do indeed reduce repair and maintenance rates.

Table 1. — Data Comparisons, One Corporation Farm and 46 Family Farms

Machine	No. of data, machine-yr.[a]		Av. annual use, acres or hr.[b]		Av. machine age, yr.		Av. annual repair rates, ¢/A. or hr. and (s)[c]	
	Corp.	Family	Corp.	Family	Corp.	Family	Corp.	Family
Tractors (diesel only)	102	317	777	422	2.3	3.4	39.0 (21)	53.0 (77)
Plows	35	259	1,424	264	2.3	6.1	24.0 (24)	28.0 (102)
Disk harrows	38	120	1,834	668	2.2	5.4	3.6 (4.5)	2.7 (5.5)
Stalk choppers	14	65	1,713	260	1.4	6.3	6.8 (5.2)	15.0 (28)
Field cultivators	38	154	1,167	485	2.2	5.8	8.4 (8.3)	3.5 (5.1)
Corn planters	81	211	666	390	1.5	4.7	9.7 (3.6)	8.7 (16.8)
Grain drills	14	22	209	108	4.6	7.0	8.2 (11.7)	1.4 (5.5)
Row cultivators	60	132	1,235	577	2.9	5.2	6.8 (12.5)	3.8 (3.9)
Rotary hoes	25	38	1,934	339	2.5	9.0	1.4 (2.2)	.4 (1.1)
Sprayers	28	13	867	202	15.0(est)	6.5	6.0 (1.5)	22.0 (58)
Combines	36	296	1,464	545	2.6	4.2	27.0 (25)	67.0 (109)
Corn heads	27	[d]	1,419	[d]	2.1	[d]	11.0 (16)	[d]
Forage harvester	13	16	478	100	1.7	6.7	34.0 (32)	65.0 (53)

[a] A machine-year is one season's operation. Data obtained from one machine for 10 years or from two machines for 5 years are each counted as 10 machine-years.
[b] Hours for tractors; acres for implements.
[c] The standard deviation(s) is given in parentheses.
[d] Corn heads included with combines on family farms.

Depreciation and other costs

Machines' reliability, or their ability to operate without failure, affects costs although it can not be assigned an exact dollar value. A breakdown is more costly on the large farm, where stoppage of any one machine may bring the whole system to a halt. The corporation farm's short-term trade-in policy arises from the belief that reliability decreases with machine age.

Other costs include interest, storage, insurance, and tax charges, but these are about the same for both types of farm. Depreciation is thus the only significant charge to add to repair costs. The corporation farm would be expected to have an advantage only if it could buy cheaper and get a good price for its used equipment, since it uses its machines during the period of greatest depreciation. The family farms can compete successfully if they can keep their machines running for a longer time, thus reducing annual depreciation costs.

Publications giving prices for used farm machinery were used to estimate annual depreciation. Assuming the average 4-year trade-in period for the corporation farm, a depreciation of about 52 percent of list price could be expected for tractors and 63 percent for implements. Comparable figures for the family farms, with an average trade-in period of 10 years, are 74 percent and 84 percent.

If the corporation farm can buy at an estimated 20 percent discount, its annual depreciation cost will be 8.0 percent of list price for tractors and 10.8 percent for implements, as compared with 7.4 percent and 8.4 percent for family farms.

Thus, even with a purchase discount the corporation farm's annual depreciation costs are higher than costs for the family farms. Some family farms can buy at discount too, and the longer life typical of the equipment on family farms gives them substantially lower annual depreciation costs.

But the fairest comparison is based on the sum of depreciation and repair costs per unit of machine use.

Table 2. — Depreciation Plus Repair and Maintenance Costs

Machine	Cost per A. or hr.[a]	
	Corp.	Family
Tractors, hr.	$1.42	$2.07
Plows	.35	.66
Combines	2.28	2.94
Forage harvesters	1.10	3.88
Stalk choppers	.15	.52
Sprayers	.12	.47
Planters	.20	.44
Grain drills	.74	.60
Disk harrows	.14	.18
Rotary hoes	.08	.14
Field cultivators	.29	.19
Row cultivators	.24	.17

[a] Hours for tractors; acres for implements.

Table 2 makes this comparison. Typical list prices *without* purchase discounts were used for the corporation farm; actual prices paid were used for the family farms. In most cases the corporation machinery system had substantially lower costs.

In summary, the corporation farm achieves lower machine costs because it spreads depreciation cost over more units of use. To compete, the manager of the family farm must follow all the best machinery management practices such as preventive maintenance, knowledgeable machine adjustments, and careful field operations. Most important, he must have large amounts of productive use for his machines.

Sweet corn plots, showing effects of low nitrogen levels at left and high levels at right. Fresh weight and protein content of corn rose significantly in response to high levels of soil nitrogen, but nitrate content did not increase appreciably.

Nitrates in Vegetables: Can They Be a Hazard?

WALTER E. SPLITTSTOESSER and JOSEPH S. VANDEMARK

Recently some alarm has been expressed about the potential hazards of nitrates in certain foods.

As a rule, there isn't much to worry about. Nitrates are natural constituents of food and are eaten every day. They are usually absorbed very rapidly from the stomach and upper gastrointestinal tract, and excreted. Moreover, in the quantities that normally occur, there is no danger of nitrates becoming toxic except under four types of condition:

1. The microbial environment of cattle causes reduction of nitrate to nitrite, which may result in toxicity in feeds with high nitrate. In horses, the enlarged cecum and colon may also provide a location for microbial reduction of nitrate.

2. The low stomach acidity of infants under about 4 months of age may allow microbes to grow and reduce nitrate.

3. When spinach is stored under conditions that allow microbial growth, nitrate may be reduced to nitrite.

4. Reduction of nitrate to nitrite may occur in damp forage materials with a high nitrate content.

But what if the level of nitrate is increased? This question particularly applies to vegetables, which are high in nitrate to start with. (Fruits contain only minor amounts.) Applying large amounts of nitrogen fertilizer can cause extra nitrates to accumulate in vegetables. Light intensity, photoperiod, cultivar, harvest date, time of day harvested, herbicide applications, and temperature also influence nitrate level. In fact, these influences are as important as fertilizer N. Nitrate is not accumulated uniformly in the various plant tissues and organs, and the amount may vary even within a tissue.

Nine crops studied

In a recent study, we grew nine vegetable crops with four levels of N fertilizer, and observed yield response and accumulations of protein and nitrate. Residual nitrogen in the soil (Drummer silty clay loam) was considered when making N applications.

The crops were: Salad Bowl lettuce, Green Wave mustard, Emerald Cross cabbage, Vates collards, Tenderpod snap beans, Ruby Queen beets, Gold Cup sweet corn, Campbell 28 tomatoes, and Yolo Wonder peppers. Snap beans, sweet corn, and beets were direct-seeded; other crops were transplanted.

Each plot consisted of three 8-meter rows with the middle 4 meters being sampled. Spacing within the row was similar to that used commercially but the spacing between rows was 1 meter. The plots were weeded by hand.

Tomato fruits were harvested at three dates and total yields reported. The other crops were harvested once in midsummer. The fresh weight of only the edible plant part was determined. Aliquots of the edible harvest were used for nitrate and protein determinations. Nitrate-N was determined in the fresh material and total protein content in the dried material.

Protein, fresh weight, nitrates

Total protein and fresh weight tended to increase with increasing levels of N fertilizer, especially in mustard (see table). However, in lettuce, collards, beets, and tomatoes, the increase from the lowest to the next lowest level of N did not cause a significant increase in protein. In snap beans, protein did not increase significantly until the highest level of N was applied. This may be expected in snap beans as their symbionts are energetic fixers of nitrogen.

In some crops nitrate concentration varied considerably in response to added N (see table). Mustard and collards increased significantly in nitrate with increased levels of N. This is to be expected, since leafy vegetables are known to accumulate nitrate. However, lettuce and cabbage were significantly greater in nitrate only at the two higher levels

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Effect of N Fertilizer on Total Protein, Fresh Weight, and Nitrate-N Concentration in Nine Vegetables[a]

Crop	Soil N,[b] kg/ha[c]	Total protein, kg/ha[c]	Fresh wt., kg/ha[c]	Nitrate, ppm of fresh wt.
Lettuce (leaves)	22	128.1 a	2530 a	180 a
	45	130.0 a	2630 a	250 a
	112	143.8 b	3140 b	460 b
	448	180.6 c	3750 c	540 b
Mustard (leaves)	22	3.8 a	240 a	490 a
	45	30.0 b	660 b	660 b
	112	93.1 c	2060 c	780 c
	448	144.4 d	2440 d	1120 d
Collards (leaves)	22	351.3 a	2350 a	720 a
	45	355.0 a	2670 ab	1000 b
	112	606.3 b	3280 b	1160 c
	448	948.1 c	4550 c	1210 c
Cabbage (heads)	22	160.6 a	3190 a	35 a
	45	202.5 b	3520 b	40 a
	112	224.4 b	3560 b	180 b
	448	264.4 c	4830 c	180 b
Snap beans (pods)	22	113.1 a	890 a	160 a
	45	123.1 a	1030 a	160 a
	112	138.8 a	1270 a	170 a
	448	183.8 b	1690 b	290 b
Beets (roots)	22	70.6 a	840 a	120 a
	45	73.8 a	980 a	120 a
	112	112.5 b	1360 b	160 a
	448	223.1 c	2350 c	150 a
Corn (kernels)	22	17.5 a	140 a	150 a
	45	38.1 b	240 a	140 a
	112	78.9 c	470 b	170 a
	448	123.8 d	660 c	170 a
Tomato (fruit)	22	240.6 a	3940 a	0
	45	260.6 a	4330 b	0
	112	389.4 b	5350 c	0
	448	635.6 c	6660 d	0
Pepper (fruit)	22	21.3 a	330 a	40 a
	45	36.3 b	470 a	40 a
	112	46.3 c	700 b	60 a
	448	83.1 d	1500 c	30 a

[a] Means in each column for each crop, if not followed by the same letter, are significantly different at the 5-percent level of confidence.
[b] Soil N includes residual and applied N.
[c] A kilogram (kg) = 2.2046 pounds; a hectare (ha) = 2.471 acres. Therefore 1 kilogram per hectare is about equal to 1 pound per acre.

of applied N. Snap beans did not increase significantly in nitrate until the highest level of N was reached. Nitrate levels in beets, corn, and peppers were low at all levels of N. Tomato fruit contained no detectable nitrate at all.

Although about 1,200 ppm of nitrate were found in mustard and collards, this level does not appear to be excessive, since 3,000 ppm are permitted in spinach, a very similar vegetable. Nitrates in foods currently consumed apparently pose no major health hazard even after the addition of N fertilizer.

Digestibility of Cottonwood By Ruminant Microorganisms

M. A. AKHTAR and C. S. WALTERS

Some experts are predicting a serious food shortage for the future. If this prediction comes true, corn and other feed grains now fed to livestock may have to be used as human food and new feeds may have to be developed for livestock.

It is possible that dairymen and cattle producers will turn to feeds made of wood residues as a replacement for both conventional roughage and concentrates. Wood has the advantage of being high in energy-rich cellulose and hemicelluloses. Unfortunately, however, untreated wood is virtually indigestible by ruminant microorganisms. The problem is primarily due to the close chemical and physical association of cellulose with lignin. Once this bond is broken, wood becomes much more digestible by ruminants.

Various methods tried

Many investigators have been interested in breaking the lignocellulosic bond or in reducing the amount of lignin to increase the digestibility of wood.

Various physical and chemical treatments have been tried. Among the physical treatments that have been investigated are irradiation by high-energy electrons, and reduction of the wood to micron-sized particles. Chemical treatments include treatment with anhydrous-liquid or gaseous ammonia, steeping in aqueous alkali solutions, and vapor-phase treatment with sulfur dioxide. These treatments have been variably successful with different woods.

Recently Bender, Heany, and their associates in Canada steamed the wood for ½ to 2 hours at 100-110 pounds pressure per square inch. They observed that digestibility of aspen increased two to three times and that of other hardwoods almost doubled.

Fahrens and his associates in Great Britain, after studying the decay of wood by white-rot fungi, reported that most of these fungi produced phenol-oxidase enzymes, which in turn oxidized the lignin. This weakened the cellulose-lignin complex and increased the ratio of cellulose to lignin.

Since brown-rot fungi are reported to attack cellulose and hemicelluloses primarily, their effect on the cellulose-lignin bond is expected to resemble that of white-rot fungi. However, the residue left by brown-rot fungi is largely lignin, which is

M. A. Akhtar is Graduate Research Assistant in Forestry; C. S. Walters is Professor of Wood Technology and Utilization. The authors are indebted to F. C. Hinds, Associate Professor of Animal Science, for his counsel and advice during the course of the study.

Table 1. — Dry Matter Digestibility Percentages for Cottonwood Sawdust Subjected to Ruminant Microorganisms After Various Treatments (Three Rumen Fluid Samples From Each of Two Cows)

Treatment of sawdust	Rumen fluid from cow 1			Rumen fluid from cow 2		
	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
	digestibility percentage					
Untreated	17.58	16.31	15.56	14.56	15.99	15.00
Steamed at 30 p.s.i. for 24 hours	22.12	20.03	21.91	23.81	20.93	21.78
Steamed at 30 p.s.i. for 48 hours	32.68	30.57	32.27	25.78	28.45	25.20
Decayed for 4 weeks	17.40	19.17	16.18	15.31	13.72	18.49
Decayed for 8 weeks	16.85	12.49	17.19	10.73	13.39	12.39

harder for the ruminant microorganisms to digest than is cellulose.

The search for a simple, inexpensive but effective treatment goes on. It seems that no single treatment will be equally effective for all wood species, hence there is a need to work out appropriate treatments for various wood residues. In the study reported here, we investigated the effect of steaming and decay on the digestibility of cottonwood by ruminant microorganisms.

How study was conducted

Cottonwood (*Populus deltoides* Bartr.) chips were ground in a Wiley mill until the sawdust or meal passed through a 40-mesh screen. The meal substrates were divided into five portions, which were sterilized by propylene oxide.

Two portions were steamed at 30 pounds pressure per square inch, one for 24 hours and the other for 48 hours. The next two portions were inoculated with a brown-rot fungus (*Poria monticola* Murr.) and incubated for 4 or 8 weeks at 27° C. and 70 percent relative humidity. The last portion was left untreated as a control. All five substrates were finally dried at 100° C. for 48 hours.

The digestibility of these substrates was determined in accordance with the *in vitro* procedure devised by Tilley and Terry in 1963. Three 0.25-gram samples of each oven-dried substrate were tested. Each sample was put into a 50-milliliter screw-capped glass tube and 3 milliliters of distilled water was added to each. The tubes were kept under 70 cm. (Hg) vacuum for 10 to 15 minutes, after which 17 milliliters of buffer solution and 17 milliliters of well-agitated rumen fluid were added to each tube. The tubes were then gassed with carbon dioxide and tightly sealed.

All tubes were incubated horizontally at 39° C. in a water bath for 96 hours. The tubes were shaken periodically. After incubation, the tubes were centrifuged at 1800 X gravity for 15 minutes and the supernatant fluid was decanted by suction. The settled solids were resuspended in 35 milliliters of water and again centrifuged and decanted. The residue was dried at 100° C. for 48 hours. Tubes containing only rumen fluid and buffer solution were used to correct for the dry matter contributed by rumen fluid. Dry matter (D.M.) digestibility was calculated by the following formula:

$$\text{Digestibility percent} = \frac{0.25 - \left\{\begin{matrix}\text{residual} \\ \text{D.M.}\end{matrix} - \begin{matrix}\text{control} \\ \text{D.M.}\end{matrix}\right\} \times 100}{0.25}$$

The experiment was repeated, using the rumen fluid from a different cow.

Results of fungal decay

Exposing the wood to fungal decay for 4 weeks somewhat increased dry matter digestibility (see tables). However, cottonwood that was decayed for 8 weeks had significantly lower dry matter digestibility than did the untreated samples. These results are attributed to a higher lignin content in the decayed substrate and less carbohydrates for rumen microorganisms.

Table 2. — Mean Digestibility Percentages for Cottonwood Sawdust Subjected to Ruminant Microorganisms

Treatment of sowdust	Rumen fluid from		Mean
	Cow 1	Cow 2	
	digestibility pct.		
Untreated	16.48	15.18	15.83
Steamed at 30 p.s.i.			
For 24 hr.	21.35	22.17	21.76
For 48 hr.	31.84	26.48	29.16
Decayed for 4 wk.	17.58	15.99	16.79
Decayed for 8 wk.	15.51	12.17	13.17
Mean	20.55	18.40	.....

Steaming effective

Of the five treatments, steaming the sawdust at 30 pounds pressure per square inch (134° C) for 48 hours gave the best results. The difference in digestibility percentage between this treatment and the untreated sample was highly significant. Steaming for 48 hours also gave 34 percent more digestibility than steaming for 24 hours.

Our results might be compared with those of Bender and his associates. They steamed the wood for shorter times than we did, using a higher pressure (100 to 110 pounds per square inch) and a higher temperature (170° to 173° C.) Dry matter digestibility for some of the treatments after 48 hours' incubation was:

Hours steamed	*Digestibility, percent*
2.0	56.5
2.0	50.8
1.0	43.3
1.0	46.2
0.5	44.8
0.5	50.7
0.5	53.0

Obviously, our combination of a longer steaming time with a lower temperature was not as effective as the shorter steaming time and higher temperatures used by Bender and his co-workers. It appears that a pressure of perhaps 100 pounds per square inch and a temperature of 170° C. or even higher is necessary for the greatest digestibility of cottonwood by ruminant microorganisms.

Soybeans as A Garden Vegetable

MEL C. CHU and HENRY E. HADLEY

With rising food prices, mature dry soybeans have become a popular source of protein in the U.S. diet. However, green soybeans are not yet widely used as a vegetable in this country, although they have long been popular in the Orient and their use in the United States was recommended as early as the 1930's.

In nutrient value, soybeans are comparable to peas (Table 1), but are much higher in calcium and vitamin A. They also contain vitamin C, which is lacking in peas.

Soybean plants are drouth-resistant, productive, and easy to grow. They are therefore highly recommended for the home garden.

Regular field varieties may be grown for eating in the green stage. There are also special vegetable types, with beans that are usually larger than the field types, have a mild nutty flavor rather than a raw-bean taste, and cook more easily.

In the following list of some suggested varieties, the ones that are italicized are particularly good as vegetables. A May planting date is assumed in indicating approximate harvest dates.

Very early (harvest before late August) — Pando, Sioux

Early (late August to mid-September) — Bansei, Disoy, Fuji, Hakuho, Hark, *Kanum, Kanrich,* Magna, Okuhara Early, *Sac, Sousei*

Intermediate (early to mid-September) — Bonus, Illington, *Jogun,* Kanro, *Kim,* Protana, Provar, Sodefuri, *Verde, Willomi*

Late (middle to late September) — Higan, *Hokkaido, Imperial*

Table 2 shows examples of harvest dates and average yields for seven representative varieties that were seeded at Urbana in July, 1973. The high yield of Hokkaido was due to the fact that it is a late variety and also to its large bean size.

Planting and growing

In central Illinois, three or four early to late varieties seeded at the same time in May, or one variety seeded on different dates should provide fresh green soybeans from late July to October.

Soybean plants do not need a very rich soil. In fact, too much nitrogen in the soil may cause excessive vegetative growth and possibly delay pod bearing. Mellow or sandy loams are best for planting. If you are growing soybeans for the first time, it would be very helpful to get some soil from a field where soybeans have previously grown, and scatter it in your garden. Bacteria in this soil will help the soybeans to utilize nitrogen from the air. If you don't have bacteria in your soil, apply nitrogen fertilizer.

Seed 1 inch deep, leaving 5 inches between plants and 20 to 30 inches between rows. As soon as the seedlings appear, cultivate often enough to keep the weeds down.

Harvesting, storing, cooking

When the pods are plump and the seeds are nearly full size but still completely green, cut off the plants near the surface of the ground, and take them to a shady place for removing the pods. Remember that the beans will lose much of their tenderness when they are too ripe.

The green pods can be kept in the refrigerator for several weeks, or the beans can be frozen after shelling and stored much longer. The beans must be frozen within a few hours after harvest, or they will lose their natural sweetness before they even enter the freezer. Pods can be shelled easily by the following method: (1) Pour boiling water over the pods; (2) let them stand in the water for 5 minutes; (3) drain the pods and let them cool; (4) break them crosswise and squeeze out the beans.

To cook the shelled beans, use 1 cup of boiling water with ¾ teaspoon of salt for each 2 cups of beans. Use a large saucepan to allow for foaming. Bring the beans to a boil under cover and boil for 15 to 20 minutes. Drain the beans and season to taste. The beans may also be boiled in the pod for 25 minutes; pods are removed as the beans are eaten.

You may like to try the Chinese method of frying the beans with vegetable oil. This usually takes only a few minutes. Chopped beef, pork, or ham is mixed with the beans while frying. Shrimp, mushrooms, chopped water chestnuts, or bamboo shoots can also be used. If you like softer beans, they can be boiled before frying.

Table 1. — Nutrient Value per 100 Grams in Green Soybeans, Dry Mature Soybeans, and Peas[a]

Nutrient	Soybeans		Peas
	Green	Dry	
Calories	123	399	135
Water, gr.	69.5	12.0	62.0
Protein, gr.	13.2	34.3	10.6
Fat, gr.	3.6	17.0	0.5
Corbohydrates, gr.	8.8	27.2	21.1
Fiber, gr.	1.8	4.5	3.7
Ash, gr.	1.7	5.0	1.3
Calcium, mg.	109	192	6
Phosphorus, mg.	246	507	225
Iron, mg.	8	7	8
Vitamin A, I.U.	400	10	20
Vitamin B_1, mg.	0.3	0.5	0.3
Vitamin B_2, mg.	0.07	0.2	0.08
Vitamin C, mg.	45	0	0

[a] Adopted from Sobura Kumazawa: *Synthetic Vegetable Crop Growing* (in Japanese). Yokendo Co., Inc., Tokyo. 1956.

Table 2. — Growing Period and Green Yield of Late-Planted Soybeans at Urbana, 1973

Variety	Planting and harvest dates	Growth period, days	Yield per 10 plants, lb.[a]
Amsoy	7/5 — 9/25	82	1.253
Calland	7/5 — 9/26	83	1.480
Clark	7/5 — 9/23	80	1.237
Hark	7/5 — 9/20	77	1.030
Harosoy	7/5 — 9/22	79	1.217
Hokkaido	7/2 — 9/26	86	2.214
Willioms	7/5 — 9/26	83	1.512

[a] Average green yield of beans with pods per 10 plants, from 30 plants of each variety.

Mel C. Chu is Assistant Horticulturist; Henry H. Hadley is Professor of Plant Genetics. The authors express their appreciation to R. L. Bernard for information about varieties.

FARM BUSINESS TRENDS

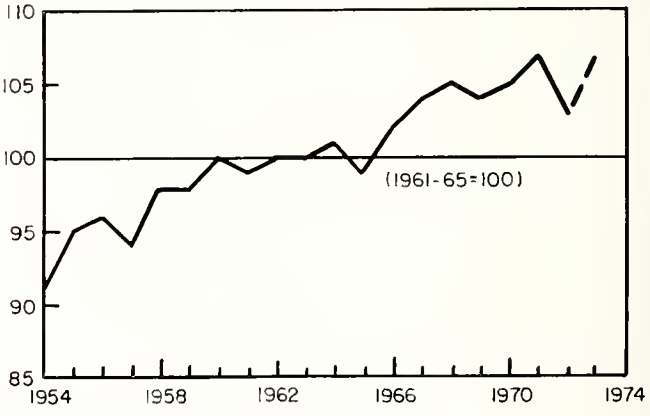
"IT'S A NEW BALLGAME," according to Secretary of Agriculture Earl L. Butz. Increases in the foreign demand for food have depleted our reserve stocks of wheat, corn, soybeans, and many other farm products. Farmers, who have been admonished to restrict crop production for most of the past 40 years, now are being urged to boost output. There are two principal reasons: Increased production of farm products would help restrain inflation. And large supplies for export are necessary to pay for imported petroleum, iron ore, steel, and other materials that are required to produce the products and services wanted by our people.

Farmers will do their best. It is advantageous for them to do so. But many fear that production will be excessive, and that farm prices and income will be depressed — as has happened on previous occasions.

Such fears may, or may not, be justified. Only time will tell. But we do know that since 1960 we have been using and exporting farm products faster than they have been produced. Most of our good land was in production in 1973, and all will be in production in 1974. World population is increasing more than 2 percent a year. The people of China, Russia, and many other countries are demanding more and better food.

It appears, too, that the galloping green revolution of a decade ago has slowed to a walk. As shown by the chart on this page, world agricultural production increased rapidly from 1954 to 1960, then leveled off for 5 years. Good gains were recorded in 1967 and 1968, but little progress has been made since then. In fact, agricultural output dipped sharply in 1972, which led to the run on the U.S. banks of wheat, corn, soybeans, etc. Production recovered in 1973, but reserves of feeds and foods have been cut to critical levels.

It now appears that programs to increase world food production will be handicapped by growing shortages and by higher costs of fossil fuels and many other raw materials. Farm operating costs surely will increase further, even if prices of farm products recede from the high levels of 1973. For 1974 and 1975, weather conditions and crop yields here in the United States and in foreign lands will be the biggest factor in determining farm prices and farm income. — *L. H. Simerl*



World agricultural production per capita.

University of Illinois at Urbana-Champaign
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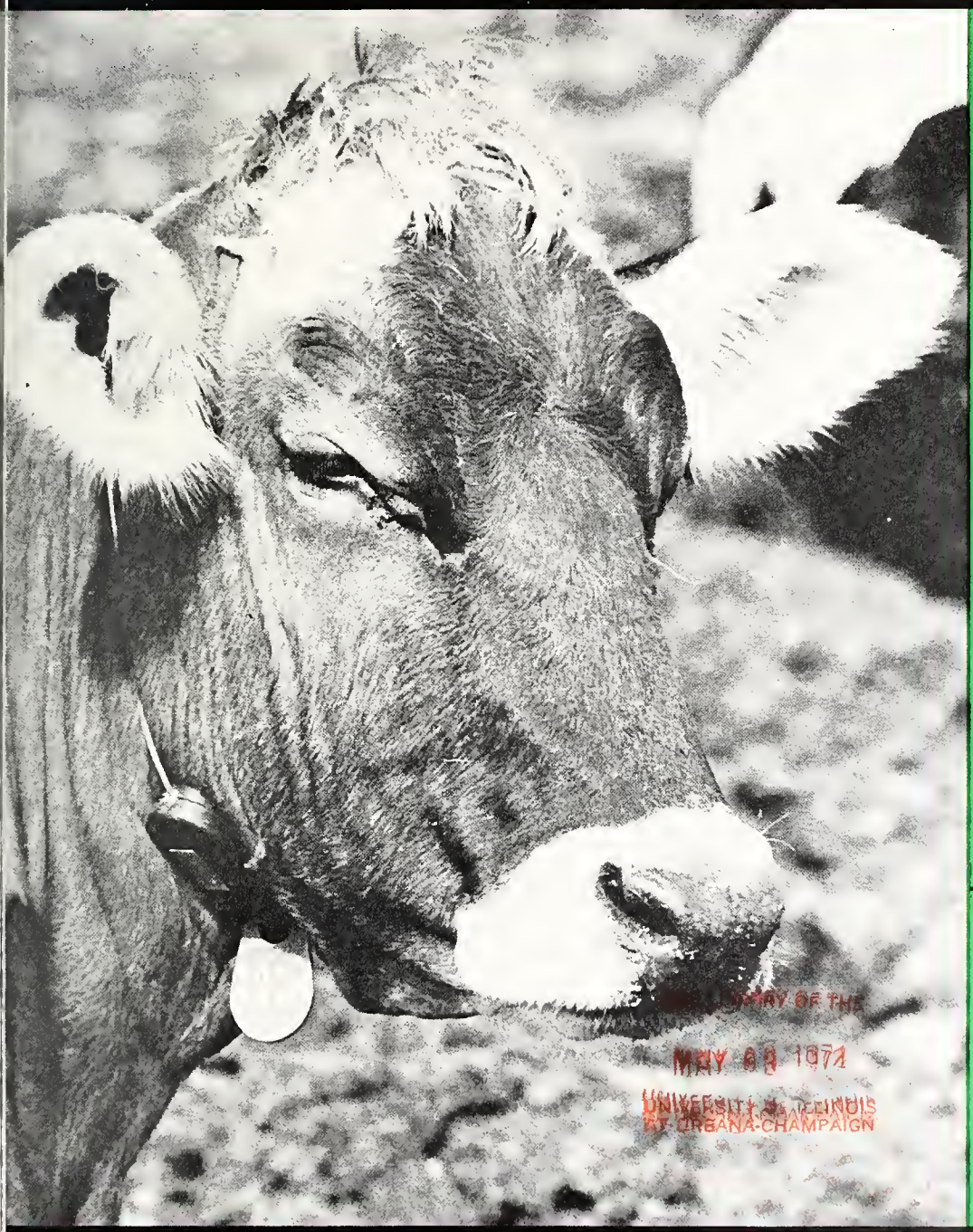

IN THIS ISSU

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UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 16, Number 2

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

(Cover picture by Paul Hixson)

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The Illinois Agricultural Experiment Station provides equal opportunities in programs and employment.

CORRECTION: In the article, "Soybeans as a Garden Vegetable," in the Winter, 1974, issue, the vitamin C content of raw peas should be 27 milligrams per 100 grams.

HOME ECONOMICS HAS NEW NAME AND NEW DIRECTOR

ON MARCH 1, the Department of Home Economics in the College of Agriculture became the School of Human Resources and Family Studies, with Dr. Pauline C. Paul as director.

The change in name and status is a recognition of the scope and variety of the residential instruction, research, and Extension work carried on under the general heading of "home economics." The new school, like the former department, includes five subject matter divisions: Child and the Family, Textiles and Clothing, Foods and Nutrition, Institutional Management, and Home Management (including interior design and housing, and family and consumption economics). Within these divisions some areas of work are based on the physical and biological sciences; some on the social sciences; and still others on the arts.

Dr. Paul's distinguished career makes her eminently qualified to direct the new school. A native of Oregon, she did her undergraduate work at Willamette University and Oregon State University. She received her M.S. degree from the University of Minnesota and her Ph.D. degree from Iowa State University, specializing in experimental foods and chemistry. Since then, she has held a variety of positions teaching foods and nutrition, conducting research, and administering home economics programs. Before assuming her new duties at Illinois, she had been professor in the Food and Nutrition Department, University of Nebraska, for seven years. In 1971-72 she had a leave of absence to serve as assistant to the Administrator for Home Economics, Cooperative State Research Services, Washington, D.C.

In her research work, she says that she has been "primarily interested in problems associated with tenderness and juiciness of meat." Currently she is working on chemical, physical, and morphological changes in muscle fibers caused by heat. She has also done research on dehydrated and frozen foods. Besides being the author or co-author of many scientific articles, she is co-editor of *Food Theory and Applications,* a reference work for food laboratories, as well as a textbook for college students.

We are confident that, under Dr. Paul's guidance, the School of Human Resources and Family Studies will continue and enhance home economics' tradition of service to the University and to the people of Illinois. — *G. W. Salisbury*

A World of Color at the Illinois Trial Garden

G. M. FOSLER

Well over 80 million people in the United States, we are told, garden as a hobby. No doubt about it — there is a growing concern about the environment in which we live and an ever-expanding interest in home beautification. And as a consequence, increasing numbers of people are visiting the Trial Garden of Annuals and Bedding Plants at the University of Illinois each summer.

The trial garden, located at Lincoln and Florida avenues in Urbana, is maintained by the Department of Horticulture. It is an integral part of the department's expanding program of teaching, extension, and research.

Objective evaluations of the many new seed-grown flower varieties introduced each year are an important service, both to the bedding plant industry and to amateur gardeners. Equally important are the cultural tests and research projects carried out in connection with the plantings.

G. M. Fosler is assistant professor of arnamental horticulture.

The trial garden serves as a convenient outdoor laboratory for university, high school, and elementary school students. In addition, hybridizers, seedsmen, landscapers, park officials, and commercial plant growers travel from distant points, even foreign countries, to study the 1½-acre plantings.

Rubbing elbows with the students and the plant industry representatives are numerous home gardeners in search of ideas for next year's flower beds. Some of them may have come on a bus tour sponsored by a garden club in Illinois or a nearby state. Other visitors are mainly interested in taking pictures or just enjoying the panorama of color. Whatever the inducement, visitors are welcome every day of the week, from dawn until dusk.

Featured are the popular and versatile flowering annuals. These frost-tender plants, used for one season's garden effects, are available in a wide range of colors and types. They provide a wealth of color in the trials from June until late fall, although most annuals reach their peak of bloom in late July and early August. Several visits each summer will impress you with their long season of bloom and reliability in our climate.

A special Trial Garden Open House for Home Gardeners, to which the public is invited, is scheduled each summer. The tentative date for 1974 is Sunday, August 4.

Hundreds of varieties

The University of Illinois trial garden ranks as one of the most comprehensive and best maintained plantings of its kind in the nation. Well over 1,300 varieties are selected for trialing each year. These are planted in rows, with each fully

Professor Fosler (*left*) and a visiting seedsman examine the petunias, which are a major attraction at the garden.

Petunia *Dancing Lady* (above) and Celosia *Red Fox* (left) will be among the many fine new varieties on display at the trial garden this year.

labeled. This arrangement facilitates planting and maintenance operations, and also makes it easy for visitors to directly compare varieties. Petunias — our most popular and dependable garden annual — take up about one-quarter of the trialing area.

Nearly 30 major seedsmen and hybridizers, both domestic and foreign, contribute the seed used in the trials. Plants are started in the Ornamental Horticulture greenhouses and are set out in late May or early June. All varieties are given comparable treatment from the very first, so that valid evaluations can be made.

In addition to the many standard catalog offerings, the alert visitor will spot a liberal sprinkling of newly introduced varieties, appearing in the trials for the very first time. You'll also find dozens of pre-introduction varieties, developed by plant breeders around the world. These are sent to us for appraisal in our rigorous midwest climate. Some of these eventually find their way into seed catalogs a year or two hence. For you, they provide a "sneak preview" of what may be on the market in the future.

"All-America Selections"

While at the trial garden, be sure to look over the interesting "All-America Selections" (AAS) trialing plots. The University of Illinois has been part of the AAS program since 1966, with G. M. Fosler as resident judge. AAS is a non-profit educational program and represents the only accepted rating system in North America for seed-grown flower varieties. AAS might, in some respects, be called the "Miss America" contest for this important category of garden ornamentals. It is paralleled in Europe and England by the Fleuroselect and All-Britain awards.

Current entries in this international competition for newly developed, unnamed varieties are included in our plots each season, appearing only under code numbers. They are interplanted with the closest competitive varieties already in commerce. Entries are voluntarily submitted to the AAS organization by the world's private, commercial, and government-sponsored plant breeders. Seed samples are then distributed to the judges without any information concerning origin or source.

There are currently 30 AAS flower trialing centers in the United States and Canada. Judges include university professors, directors of botanical gardens, and the presidents and research directors of America's leading seed houses. AAS judges receive no compensation for their efforts.

Entries are judged objectively and strictly according to their performance in each of the AAS trial gardens. The scores are then tabulated. Top-rated entries are subsequently publicized to the gardening world as AAS Gold, Silver, or Bronze Medal winners. These meritorious few represent, without doubt, the very best varieties of their respective types to date. Seed catalogs and seed racks feature AAS varieties, and your local garden center or greenhouse can supply plants of the recent winners.

Six new AAS award winners are being introduced to the gardening public in 1974: Celosia *Red Fox* (Bronze Medal); Cosmos *Diablo* (Bronze Medal); F_1 Dianthus *Magic Charms* (Bronze Medal); F_1 Marigold *Showboat* (Bronze Medal); and F_1 Zinnias *Peter Pan Orange* (Silver Medal) and *Scarlet Ruffles* (Gold Medal).

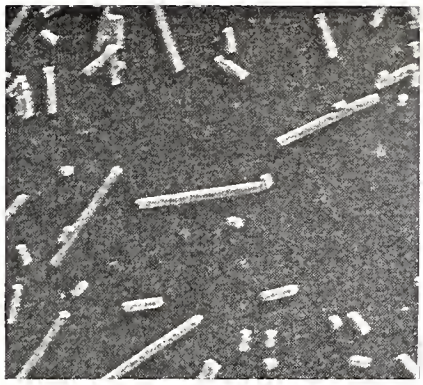
These varieties, as well as hundreds of others, will be on display when you visit the trial garden next summer.

Beautify the environment

Your University plays an important role in evaluating new flower varieties, in bringing to your attention the vast array of available plant materials, in fostering their effective use, and in promoting better gardening. Why not help beautify the environment — at least your little corner of the world — with colorful flowering annuals?

Zinnia ***Peter Pan Orange*** (left) and Dianthus ***Magic Charms*** are 1974 All-America award-winning varieties.

Tobacco ringspot virus.



Tobacco mosaic virus.

Tobacco etch virus.

Virus Diseases of Vegetables

G. M. MILBRATH

Virus diseases attack all major crops grown in Illinois. Damage is often severe because of the speed with which viruses can spread through an area. Fields of vegetables that were free from diseases when planted may be a partial or total loss by midseason.

What are the viruses?

Plant viruses, like human viruses, are microscopic particles that can be identified on the basis of their shape, size, chemical composition, and means of transmission. They can not be seen with ordinary laboratory light transmission microscopes, but they are visible in electron transmission microscopes. Their hereditary material, which is carried in the nucleic acid of the particles, can undergo mutations.

The particles may be spheres (such as tobacco ringspot virus), rigid rods (such as tobacco mosaic virus), or flexuous, threadlike rods (such as tobacco etch virus). Examples of each are illustrated above.

How viruses are spread

Plant viruses are spread in many ways. Some of the filamentous viruses such as soybean mosaic and bean common mosaic are seed-borne; however, turnip mosaic is found in infected roots of horseradish. The most common means of spread is by insects, particularly winged aphids.

Aphids have an incredible capability to reproduce rapidly. A single aphid may produce 50 to 60 young in its lifetime. Each of the young reaches maturity in two to three weeks and in turn gives birth to young. By the time a grower can see aphids on a plant, the population is already enormous.

A special problem

One large group of viruses, which are flexuous, threadlike particles, infects a large number of vegetable crops (see table). These viruses (called potyviruses) have become an increasing problem where the same crop is grown in large or adjacent fields.

The viruses spread into commercial fields or home gardens from infected plants such as weeds or volunteers from previous years. Perennial weeds growing in wastelands adjacent to fields provide a natural reservoir both for the virus and for aphids. The aphids carry the virus to a susceptible host and, by their feeding action, introduce virus particles into the new host. This serves as an initial infection center in the field for further spread of the virus.

Maize dwarf mosaic virus (MDMV) occurs on corn each year in southern Illinois. Corn leaf aphids increase on MDMV-infected Johnsongrass and the winged aphids transmit the virus to adjacent corn fields. The virus spreads from these initial infections throughout the area where corn and Johnsongrass are common.

Bell peppers attacked

During the last several years bell peppers grown in commercial fields in Union County have suffered from a serious virus problem. Some fields have become unprofitable to harvest

Common Diseases Caused by Viruses in Illinois

Host	Disease
Beans	Bean common mosaic, bean yellow mosaic
Corn	Maize dwarf mosaic
Curcifers (horseradish, turnips)	Turnip mosaic
Curcurbits (cantaloupes, squash)	Watermelon mosaic, tobacco ringspot, cucumber mosaic
Gladiolus	Bean yellow mosaic
Johnsongross	Maize dwarf mosaic
Peppers	Tobacco etch, potato Y
Soybeans	Soybean mosaic, tobacco ringspot
Tomatoes	Tabacco mosaic

G. M. Milbroth is assistant professor of plant pathology.

after two or three pickings. The pepper plants show leaf mosaics, mottles, and veinclearing; but the primary damage occurs in the fruits, which are so stunted and badly distorted that they are unmarketable. The reduction in yield represents a loss to the grower and a higher price for the consumer.

The virus involved has been identified as tobacco etch virus, which is aphid-transmitted. The virus is a problem not only in southern Illinois, but wherever peppers, tomatoes, and tobacco are grown.

Many of the common weeds in Union County have been collected and tested for the presence of the tobacco etch virus. The virus has been consistently isolated from horse nettle growing near pepper fields. Testing of other weeds is continuing.

Control

The successful control of a virus in a particular crop depends on a thorough knowledge of its spread and the sources of the virus in an area. It is essential to eliminate, when possible, virus-infected plants, to use virus-free transplants, and to eliminate virus reservoirs such as perennial weeds.

Good aphid-control programs will reduce the spread of the viruses in a field or garden, but insecticides do not act fast enough to prevent the aphids from transmitting the viruses they are carrying. It takes only a few minutes for the aphids to acquire the viruses from diseased plants, fly to healthy plants, and inoculate them. No chemical sprays are available for control of viruses at present.

The use of resistant or tolerant varieties offers a means of controlling virus diseases. During the last two years the Experiment Station and county advisers have cooperated in evaluating experimental pepper varieties from the University of Florida. These lines are resistant to tobacco etch virus, have fruit qualities suitable for market, and are early-maturing. The continued evaluation of resistant selections should help to reduce the effects of this virus in peppers in the next few years.

Freezing Does Not Kill All Bacteria in Food

LLOYD D. WITTER and GEOFFREY G. GENGENBACHER

During the past few years the issue of food product safety has exploded into a serious problem that will probably last a long time. According to Dr. V. O. Wodicka, director of the Bureau of Foods of the Food and Drug Administration, the principal hazard of our food supplies is microbial contamination.

At the same time that microbial contamination has been on the rise, consumption of precooked frozen foods has also clearly increased. The marriage of these two current trends has emphasized the great need for further information on the survival of important food-poisoning bacteria during freezing, thawing, and frozen storage.

When humans are exposed to freezing conditions they die; a frozen individual is assumed to be and is dead. By analogy, therefore, it is fetching to assume that other living forms will die when frozen. For this reason most consumers have perfect confidence in the safety of frozen foods and assume that they surely do not contain any viable disease-producing bacteria.

It is true that many types of bacteria are rather easily killed by the freezing operation; if they do survive this operation, they often die while stored in the freezer. Many other bacteria, however, not only survive freezing but are successfully preserved by freezing and freezer storage. For example, bacterial starter cultures which are used in the manufacture of buttermilk and cottage cheese are routinely frozen for distribution to dairy plants and for storage. Bacteria used in the manufacture of fermented sausages in the meat industry are also commonly frozen.

Lloyd D. Witter is professor of food microbiology; Geoffrey G. Gengenbacher is a graduate research assistant.

With the varying reactions of bacteria to freezing, it is important to know the fate of bacteria that may cause food poisoning. This can be determined only by experience or by experimentation.

Three kinds of bacteria important

Three food poisoning bacteria that may be of concern in frozen foods are *Staphylococcus aureus, Vibrio parahaemolyticus,* and species of the genus *Salmonella.* Both vibrio and salmonella food poisonings are true infections. They are due to large numbers of organisms in the intestinal tract. These large numbers can result either from ingestion of highly contaminated food or from multiplication of the organisms in the intestines. Regardless, the bacteria must be present in the consumed food for the afflictions to occur.

Staphylococcal food poisoning is not a true infection. *S. aureus* produces a toxin which is responsible for the illness. Large numbers of bacteria are necessary to produce enough toxin to cause food poisoning. However, viable bacteria do not need to be present in the food at the time of ingestion for food poisoning to occur.

Staphylococcal food poisoning

Staphylococcal food poisoning is the most common type of food poisoning in the United States. In 1972 it accounted for 32.5 percent of all confirmed food-borne cases of poisoning as reported by the Center for Disease Control at Atlanta, Georgia. (These food-poisoning cases included those due to such causes as parasites,

viruses, and chemicals, as well as those due to bacteria.)

Symptoms of staphylococcal food poisoning appear abruptly about five hours after the contaminated food has been eaten. These symptoms will probably include nausea, diarrhea, vomiting, and severe prostration. This severe prostration, absence of a fever, and the relatively short incubation time differentiate staphylococcal food poisoning from the other two bacterial food poisonings considered here. Also, the illness lasts a shorter time — 24 hours or less. This type of food poisoning is not fatal.

Salmonella food poisoning

Salmonella food poisoning accounted for 31.4 percent of all confirmed food-borne cases of poisoning in 1972 — a close second to staphylococcus. A person with salmonella food poisoning will have a rather abrupt onset of symptoms roughly 12 hours, but possibly up to 24 hours, after eating. These symptoms, which usually last about two days, will probably include slight fever, slight vomiting, abdominal pain, nausea, and diarrhea. Fatalities are rare and occur only in infants and the aged.

The severity of salmonella food poisoning varies markedly with the susceptibility of the individual, the number of organisms in the food, and the infectivity of the strain of *Salmonella*. Over 1,000 strains are recognized at present, but perhaps only about two dozen of these account for 99 percent of salmonella infections. The most prominent species encountered in outbreaks is *S. typhimurium*, although other species may predominate in a given outbreak or a given locality.

Vibrio food poisoning

Food poisoning due to *V. parahaemolyticus* is very similar to that caused by salmonella. Symptoms usually appear 12 hours after the infected food is eaten, and last about two days. The affliction is characterized primarily by diarrhea and abdominal pain. Also, there are usually a slight fever, nausea, and vomiting. Fatalities are almost completely limited to aged people in poor health. Since *V. paraphaemolyticus* is a marine organism, outbreaks of vibrio food poisoning have been associated with fish and sea foods.

In Japan vibrio is the most common form of food poisoning, consistently accounting for well over 50 percent of the cases of food poisoning year after year. In the United States vibrio food poisoning has been considered unimportant and has been only rarely reported until the last several years. However, in 1972 it accounted for 12 percent of the confirmed cases of food poisoning, which makes it the fourth most common cause of food-borne illness.

Indicator bacteria

The fate of two additional organisms, *Escherichia coli* and *Streptococcus faecalis*, are also of interest to food scientists and of public health significance in frozen foods. These bacteria do not cause food poisoning, but may be used as indicators of whether sanitary precautions employed during manufacture might be improved.

In contrast to our attitude toward food-poisoning bacteria, it is hoped that indicator bacteria will not be killed by freezing. To serve effectively as indicator organisms, it is important that they be reasonably resistant to death by freezing and that they do not show a substantial death rate during frozen storage.

Detection of bacteria

To detect either indicator or food-poisoning bacteria in a food containing a mixed flora of bacteria, it is necessary to plate the food sample onto a selective growth medium. Such a selective medium contains chemicals that inhibit the growth of bacteria other than the species being selected.

Normally the bacterium being selected will grow equally well on its selective medium and on a nonselective medium that does not contain the appropriate inhibitors. However, when the bacterium is subjected to stresses such as heating or freezing, its growth may also be slightly restricted by the inhibitors in its selective medium. This difference in the ability of a stressed bacterium to initiate growth on a selective and a nonselective medium is called injury.

Death and Injury of Bacteria Due to Freezing and Storage for 4 Days at −20° C.

Bacterium	Pct. killed	Pct. injured
Staphylococcus aureus	9.1	16.5
Salmonella typhimurium	7.8	11.3
Vibrio parahaemolyticus I	80.5	....
Vibrio parahaemolyticus II	98.8	....
Vibrio parahaemolyticus III	99.98	....
Streptococcus faecolis	6.0	29.5
Escherichia coli	75.6	9.4

Five organisms studied

The three types of food-poisoning bacteria and the two indicator organisms were frozen in trypticase soy broth, which is similar to a rich bouillon. They were frozen to −20° C., at a rate of 0.21° C. per minute. After four days of storage at −20° C., they were thawed at a rate of 0.69° C. per minute and plated on both selective and nonselective media.

From the results in the table it is evident that *Streptococcus faecalis* should be chosen over *Escherichia coli* as an indicator of good manufacturing practices in frozen foods. *E. coli* was sensitive to freezing, with 75.6 percent being killed. The rather high injury rate of *S. faecalis*, however, does suggest that certain precautions will be necessary in interpreting results when a selective medium is employed.

It is also clear from the results that vibrio food poisoning should not pose a particular hazard in frozen foods. Even the most resistant of the three strains tested was substantially reduced by freezing and a brief frozen storage. On the other hand, *Salmonella* and *Staphylococcus* bacteria were only slightly reduced by freezing. It would appear that the hazard of these two food-poisoning bacteria in contaminated food is not adequately reduced by freezing and that the potential of food poisoning in frozen foods is a definite reality.

Dairy Cows Perform Well With Electronic Concentrate Feeders

A. L. DEVORE, K. E. HARSHBARGER, G. M. HYDE, E. F. OLVER, and H. B. PUCKETT

GETTING enough grain into cows capable of high milk production continues to be a major problem with loose-housing dairy operations.

Cows in early lactation usually can not consume enough grain in the milking parlor to hold peak lactation yields. If attempts are made to feed grain outside in the feed bunk in addition to what is fed at milking time, grain intake is usually poorly controlled. Moreover, cows usually have to be grouped according to production, which calls for additional labor. To develop more efficient systems, research efforts using automated feeders and feeding devices continue at the University's Dairy Automation Research Center.

An earlier article in ILLINOIS RESEARCH (Winter, 1964) described a feeding device that dispensed grain according to water intake. Later articles (Summer, 1967; Spring 1972; and Summer, 1972) featured descriptions of the facilities at the Dairy Automation Research Center. Forages and concentrates in varying amounts are fed to as many as 127 cows in five lots; or concentrates are fed to individual cows by the use of an experimental electronic concentrate feeder (or dispenser). This feeder continues to offer an alternative means of feeding grain or concentrates individually with a minimum of labor.

Three methods of feeding

The electronic feeder was compared with two other methods of feeding concentrates to 48 cows. The cows, some of which were milking over 70 pounds per day, were divided into three balanced groups.

The trial lasted for three 4-week test periods. During each test period one of the three groups received grain in the parlor at milking time; the second group received grain from the electronic feeder, which dispensed grain at any hour of the day or night; and the third group received concentrates in a complete ration mixed with forage. At the end of each period the groups were switched to a different treatment so that at the end of 12 weeks all groups had been fed by each method for one 4-week period.

There were no significant differences in milk production among the three methods of feeding concentrates (Table 1). Nor did milk fat percentage differ significantly.

Table 1. — Average Daily Milk Production per Cow During Last 3 Weeks of Each 4-Week Period

Type of feeding	Period 1	Period 2	Period 3	Treatment mean
	lb.	lb.	lb.	lb.
Parlor-fed	42.5	37.2	40.9	40.3
Electronic feeder	44.7	38.1	34.3	39.1
Group-fed	44.1	41.3	36.5	40.6
Period mean	43.8	38.7	37.2	....

Four-stall feeder

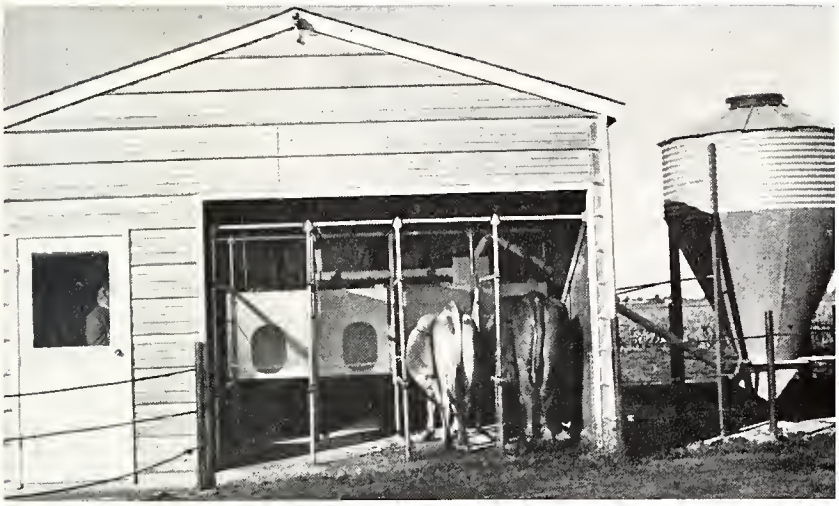
Since the single-stall electronic feeder was effective in dispensing grain according to individual cow needs for groups of 16 to 20 cows, a larger unit with four stalls was designed to handle a larger group of cows (Fig. 1). At present, studies are being conducted to determine the "carrying capacity" per stall in a multi-stall situation. Once we have determined how many cows a single stall or electronic feeder will serve, it will be easy to prescribe the number of stalls necessary for a given herd size.

Sixty cows producing 26 to 84 pounds of milk per day were assigned to a feeding trial using the four-stall unit from August 25 to November 16, 1973. Transponders were attached to the cows (see cover picture), and the prescribed recharging time was set to control grain intake for each cow according to her milk production.

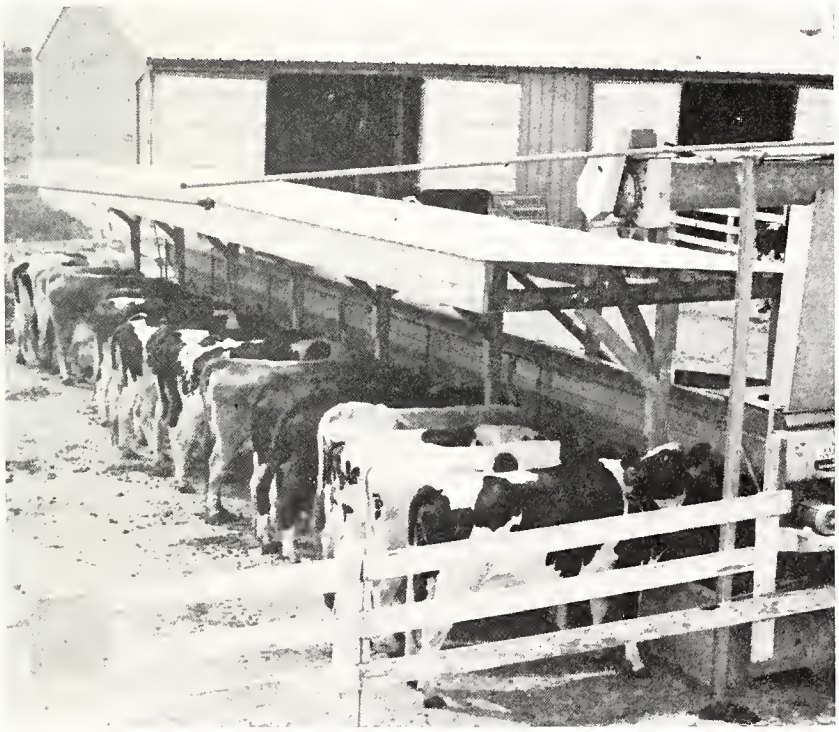
During the 12-week period the 60 cows received all their concentrates from either two, three, or four electronic feeders, with a different number of stalls being open each week. After 12 weeks, each number of stalls (two, three, or four) had been open for a total of 4 weeks. Forage (70 percent corn silage and 30 percent alfalfa haylage) was allowed free choice. At the end of 6 weeks the transponders were reset to adjust grain intake to changes in milk production.

According to the results shown in Table 2, 30 cows per electronic feeder are too many when the cows are capable of giving 40 pounds of milk or more. When the 60 cows were fed grain concentrates from only two electronic feeders, milk production was significantly lower than when they had access to three or four feeders. However, four stalls were more effective than three only in the second 6-week period. The optimum carrying capacity for each electronic feeder in the present design is apparently 20 cows.

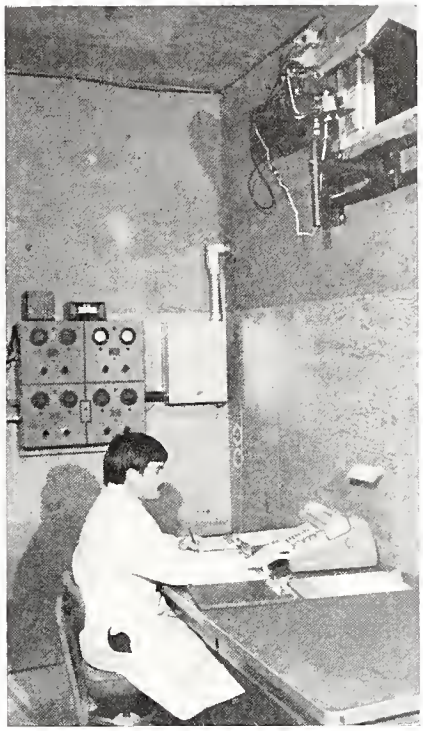
A. L. Devore is research associate and K. E. Harshbarger, professor of nutrition, Department of Dairy Science; G. M. Hyde, agricultural engineer, USDA; E. F. Olver, professor of agricultural engineering; H. B. Puckett, professor of agricultural engineering and research leader, ARS, USDA.



Cows occupy two of the four electronic stalls. (Fig. 1)



Corn silage and haylage are fed at feed bunks. (Fig. 2)



In a room behind the stalls, G. M. Hyde compiles data from the four instruments on the wall, which record stall occupancy and grain fed. Camera at upper right photographs stalls at set intervals to check cows' eating patterns. (Fig. 3)

Table 2. — Milk Production per Cow for 60 Cows Fed Grain From 2, 3, or 4 Electronic Feeder Stalls

No. of feeders	First 6 wk.	Second 6 wk.
	lb. of milk	
2	45.8	37.5
3	47.0	38.5
4	47.0	40.3

Cow behavior a problem

The social nature of dairy cows, combined with their being creatures of habit, poses a challenging management problem in using electronic feeders for a large group of cows. When the cows were allowed grain from only two feeders, the stalls were occupied 84 percent of the time while grain was being dispensed only 40 percent of this time. Cows spent as much time licking an empty feeder or just standing in the stall as they did eating, and kept other cows from using the stalls. Because of the excessive amount of time in the stalls, the cows received only 70 percent of their allowed total concentrates when fed from two electronic feeders.

When three or four stalls were open, they were occupied 77 and 75 percent of the time, respectively. However, the desired feed-dispensing time was nearly fully utilized, and the cows were able to obtain all their allowed grain. The lowered grain intake when the cows were fed from two feeders was no doubt responsible for the differences in milk production.

Efforts are being made to find out why cows spend so much time in these electronic feeder stalls when feed is not being dispensed. Changes in stall arrangement and design may increase the carrying capacity so that on a practical basis 30 to 40 cows per stall might be fed.

Textured Vegetable Protein Palatable in Meat Loaves

SUN YOON, AIKO K. PERRY, and FRANCES O. VAN DUYNE

For years various foods have been enriched with soy flours and soy protein concentrates. More recently, the advent of textured vegetable protein processed from soybeans has increased the possible uses of soy protein. With the high price of meat, many homemakers are turning to textured vegetable protein as an economical meat extender.

When textured vegetable protein was first introduced on the retail market, it was premixed with ground beef. Now it is available in a dry, unmixed form, permitting homemakers to mix it with ground meat in varying proportions. Textured vegetable protein is commonly used as a partial replacement for ground beef in meat patties, meat loaf, chili, and other mixed dishes.

It has been reported that including textured vegetable protein in meat loaves and patties increases juiciness and flavor. Data to confirm or refute these claims are needed. Also, since meat is a good source of thiamine, it should be determined if thiamine content and retention are altered by using meat and textured vegetable protein instead of all meat.

In the study reported here, data were collected for all-beef meat loaves and for loaves containing meat and hydrated vegetable protein in two different ratios.

Preparation of meat loaves

Ground beef (about 75 percent lean) was purchased from a local market each time meat loaf was prepared. The textured vegetable protein was a fortified, unflavored, colored product that meets USDA specifications for Type A school lunches. It was supplied by A. E. Staley Mfg. Co., Oak Brook, Illinois.

Table 1. — Weights of Ground Beef, Dry Textured Vegetable Protein, Water, and Beef Bouillon Used in Meat Loaves

Ingredient	Treatment		
	100% beef	85% beef	70% beef
	gm.	gm.	gm.
Ground beef	567	482	397
Vegetable protein	...	34	68
Water	...	51	102
Beef bouillon	...	1	2

Quantity recipes suggested for the school lunch program were reduced to provide lesser amounts of three meat loaf mixtures. These contained 100 percent ground beef; 85 percent beef and 15 percent hydrated vegetable protein; 70 percent meat and 30 percent vegetable protein. The last combination represents the maximum amount of hydrated vegetable protein allowed in a school lunch.

The weights of ground beef, dry vegetable protein, water, and beef bouillon used for the meat loaves are listed in Table 1. Each type of loaf was prepared five times.

To prepare the all-beef loaf, 76 grams of bread and 113 grams of milk were first combined in a mixer at low speed for 2 minutes. Then the meat, bread and milk mixture, and other ingredients (28 grams each of chopped onion and celery, 5 grams of salt, 6 grams of Worcestershire sauce, and 59 grams of slightly beaten egg) were mixed by hand for 1½ minutes. Next, 700 grams of the mixture were weighed into an aluminum loaf pan, 7⅜ x 3⅝ x 2¼ inches, and packed gently to shape. The loaf was unmolded into a weighed Pyrex baking dish, 13½ x 8¾ x 1¾ inches, and baked for 45 minutes at 350° F.

To prepare meat loaves with textured vegetable protein, the dry protein was first hydrated. One and one-half times as much water as protein by weight was boiled, the beef bouillon (in cube form) was dissolved in the water, and the liquid cooled to room temperature. The dry vegetable protein was then added and allowed to stand for 15 minutes. The designated amounts of hydrated protein were added to the reduced amounts of ground beef, and meat loaves were prepared in the same way as the all-beef loaves.

Measurements made

Immediately after baking, the meat loaves and baking dishes were weighed so that cooking losses due to evaporation could be calculated. Then the loaves were removed from the dishes so that the weights of the drippings could be determined.

Cooked meat loaves were evaluated subjectively by a taste panel. Chemical determinations of moisture, fat, and thiamine were made in triplicate on samples of raw meat loaf mixtures and cooked loaves. All data were analyzed statistically.

Cooking losses

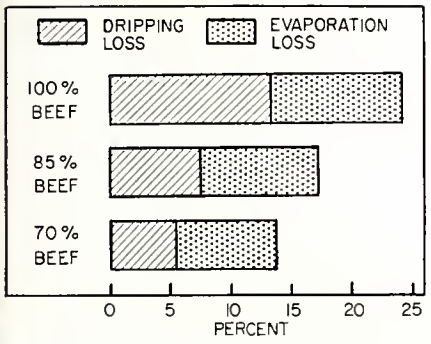
Meat loaves prepared with 100 percent ground beef had a mean total cooking loss of 24.2 percent while those containing 15 and 30 percent vegetable protein had mean losses of 17.2 and 13.6 percent, respectively (see chart). These differences were all statistically significant.

The mean dripping loss for all-beef loaves, 13.3 percent, was significantly higher than the 7.6- and 5.4-percent losses for loaves containing 15 and 30 percent vegetable protein. Differences in mean evaporation losses were small, but were still significant.

Palatability

Slices ¼ inch thick were taken from the center of a meat loaf and each slice was cut in half to provide samples for the taste panel. Four to six members of the Foods and Nutri-

Sun Yoon is a graduate research assistant; Aiko K. Perry, associate home economist; and Frances O. Van Duyne, professor of foods.



Cooking losses of meat loaves.

Table 2. — Mean Palatability Scores

Palatability factor	Treatment		
	100% beef	85% beef	70% beef
Appearance	4.1	4.5	4.5
Color	4.3	4.3	4.2
Aroma	4.4	3.8	3.4
Texture	3.9	4.1	3.9
Flavor	4.4	4.1	3.5
Total score	21.1	20.8	19.5

tion Division evaluated the loaves on the basis of five palatability factors (appearance, color, aroma, texture, and flavor). Each factor was scored on a 5-point scale with 5 corresponding to a rating of very good; 4, good; 3, fair; 2, poor; and 1, very poor. Total scores were obtained by adding scores for the five palatability factors. Mean scores for these factors and mean total scores are presented in Table 2.

Loaves containing textured vegetable protein retained more of their original shape, indicating less shrinkage, than did the all-beef loaves. This difference was reflected in mean scores for appearance that were significantly higher for the loaves with vegetable protein. Color scores did not differ significantly. Although the panel noted dark brown particles in loaves made with vegetable protein, the particles were not considered objectionable.

Partial replacement of beef with vegetable protein significantly affected aroma. The panel gave the all-beef loaves a mean score for aroma that corresponded to an above-good rating; mean scores for loaves with 15 and 30 percent vegetable protein were equivalent to ratings of high fair and fair, respectively.

Table 3. — Mean Values for Moisture, Fat, and Thiamine Contents

Treatment (pct. beef in mixture)	Moisture	Fat	Thiamine	
			As determined	Retention
	pct.	pct.	mcg./gm.	pct.
Raw mixture				
100	57.8	20.8	0.89	..
85	61.5	15.2	1.10	..
70	59.9	14.7	1.28	..
Cooked loaf				
100	59.8	14.0	0.98	83
85	60.4	11.9	1.16	88
70	60.0	10.6	1.40	94

Mean scores for texture were very similar. According to the panel, adding vegetable protein neither impaired nor improved texture. Although juiciness was not scored as such, marked differences in this characteristic would probably have affected texture. There was no indication that this occurred.

Mean flavor scores for the all-beef loaves and for those with 15 percent vegetable protein did not differ significantly, indicating that the use of this amount of vegetable protein did not impair flavor. However, loaves with 30-percent vegetable protein had a significantly lower mean flavor score.

The mean total score for all-beef loaves was 21.1 out of a possible 25, corresponding to a rating of slightly above good. Loaves containing 15 percent vegetable protein had a similar rating, while those with 30 percent rated slightly below good.

Moisture, fat, and thiamine

Raw meat loaf mixtures containing 15 percent vegetable protein had a higher mean moisture content than either all-beef mixtures or mixtures containing 30 percent vegetable protein (Table 3). These differences are probably due to variations in the moisture content of the ground meat rather than to treatment.

After cooking, the three types of loaves differed very little in moisture content. This does not bear out the claim that adding textured vegetable protein results in moister meat loaves, but it is consistent with the fact that the taste panel did not mention any increased juiciness.

Fat content was significantly higher in the all-beef mixtures than in the mixtures containing vegetable protein (Table 3). This was expected because the vegetable protein used contained very little fat. The cooked loaves were significantly lower in mean fat content than the mixtures from which they were prepared. However, the all-beef loaves still had the highest mean amount although they lost more fat in the drippings — 6.8 percent — than did the loaves with vegetable protein. Loaves with 15 percent vegetable protein lost 3.3 percent and those with 30 percent, 4.1 percent.

Mean values for thiamine content on the "as determined" basis in the raw meat loaf mixtures and in the cooked loaves increased with increasing percentages of textured vegetable protein (Table 3). The differences in the mean values of the raw mixtures were all statistically significant.

After cooking, the actual concentrations of thiamine on the as determined basis were higher than before cooking. This phenomenon occurs when losses of fat or moisture are greater than thiamine losses. However, when percent retentions of thiamine are considered, it is evident that cooking decreased the amounts of thiamine originally present. All-beef loaves had a significantly lower retention than did loaves containing vegetable protein; and loaves with 15 percent vegetable protein retained less thiamine than those with 30 percent vegetable protein.

Vegetable protein has advantages

Meat loaves prepared with 15 percent vegetable protein and 85 percent ground beef were scored by the taste panel as being highly acceptable. However, increasing the vegetable protein to 30 percent impaired flavor and aroma. Loaves with vegetable protein shrank less and had significantly lower cooking losses than all-beef loaves. They also had higher thiamine contents and percent retentions, and lower fat contents.

Hardwood Bark Mulches For Control Of Erosion On Roadsides

MICHAEL F. BOLIN and
THEODORE R. YOCOM

How to dispose of bark and other wood residues is a problem plaguing wood-utilizing industries across the United States. Indiscriminate dumping or burning is now prohibited by environmental regulations, so the best solution is to find uses for the residues.

Since 1968 the Department of Forestry has been conducting research on the use of hardwood bark to stabilize the soil on roadside slopes. Preliminary field trials were conducted at two locations: along I-70 between Effingham and Terre Haute and along I-72 west of Champaign.

Both the short- and long-term capabilities of shredded hardwood bark as a seeding mulch were observed. In the short term a mulch should reduce soil erosion from bare slopes to an acceptable level. In the long term it must provide adequate conditions for development of a vegetative cover dense enough to assure permanent slope stabilization.

The capabilities of the bark mulches proved to be exceptional in these trials even though the mulches were exposed to a 4.7-inch rain in one 8-hour period. The bark materials not only protected the soil from erosion, but also produced better vegetative cover than the other mulches used in the trials.

Drop tower utilized

Further investigations were needed to determine (1) the optimum rate of application and (2) the most effective textural composition or particulate size of the mulching media. This research was conducted in the Agricultural Engineering Department's 32-foot drop tower (Fig. 1).

In the drop tower, it is possible to control the rate, intensity, and duration of simulated rainfall on an experimental slope model. Thus the experiment can be conducted on a year-round basis and at the convenience of the researcher.

Tests that were conducted

Several mulches were tested on a clay loam topsoil provided by the Illinois Department of Transportation, Paris District. Each mulch treatment was exposed to the simulated rainfall for 30 minutes. The following variables were included:

Mulch materials. Four mulch materials were tested in addition to a control or bare soil model. The materials were a processed hardwood bark that's now being produced in the Midwest; sawdust from an Illinois sawmill; and the coarse and fine shredded bark mulches which are described below.

Textural composition of mulch. It was felt that textural composition (particle sizes) of the bark mulching materials may be as important as application rates. A classifier was used to determine distributions of the various particle sizes. The classifier separated the particles into the following size classes: $> 1''$, $> \frac{1}{2}''$, $> \frac{1}{8}''$, $> 1/16''$, $> 1/32''$, $< 1/50''$. The fine bark mulch was developed by removing all particles larger than ½ inch from the regularly ground bark. Similarly, the coarse mulch was developed by removing all particles smaller than 1/16 inch.

Mulch application rates. In the field studies previously conducted, applications of less than 20 cubic yards of bark mulch per acre did not control erosion satisfactorily. However, applications of 25 to 30 cubic yards did reduce erosion markedly. For the tower studies, two rates were tried: 30 cubic yards, to confirm the field trial results; and 40 cubic yards, to determine if higher rates were more desirable.

Slope. Two slopes, 2:1 and 3:1, were included in the tests. The 3:1 slopes comply with State of Illinois Highway Department specifications for "cut-bank" grades that parallel the highway. The 2:1 slopes comply with specifications for "fill" grades and slopes that arise from the overpasses.

Rainfall rate. Two excessively high rates of rainfall, 6 and 9 inches per hour, were selected to test the mulches' capacity to withstand extreme conditions. The ultimate concern was to establish the upper limits at which the various mulches would perform properly.

Experimental model

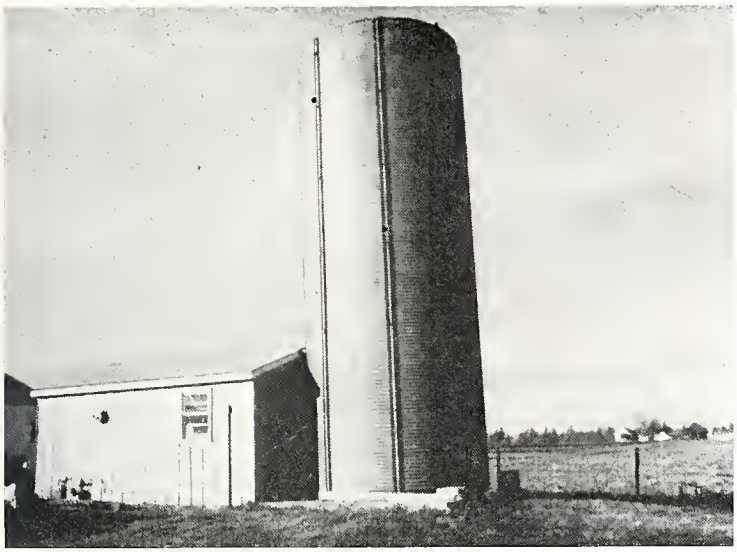
An experimental model was constructed to simulate the two slopes normally encountered along Illinois highways (Figs. 2, 5). It was designed to collect surface runoff separately from percolation water. A large trough on the front of the soil box collects the water, soil, and mulch that moves off the surface of the model. Holes drilled in the bottom of the soil box provide an outlet for the water percolating through the soil profile.

Encouraging results

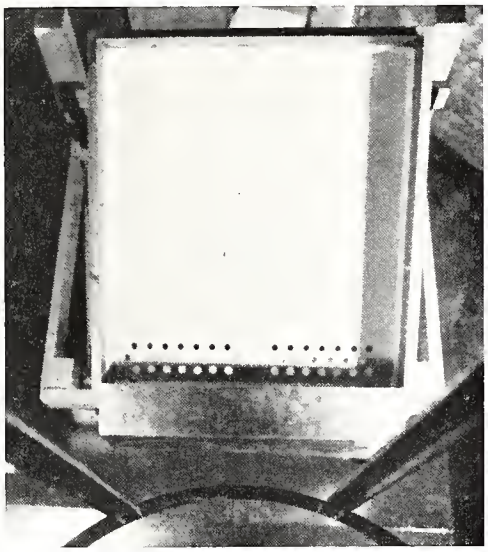
Although the data collected in the study have not yet been completely analyzed, the bark mulch was obviously very effective. It held the soil in place even when subjected to rainfall at the rate of 6 inches per hour for a full 30 minutes (Fig. 3). Under the same conditions, a sawdust mulch was severely eroded.

The information gained from this experiment will help in making precise recommendations to achieve the best possible erosion control on highway slopes with the use of wood-residue mulches.

Michael F. Bolin is assistant forester and extension specialist; Theodore R. Yocam, associate professor of forestry.

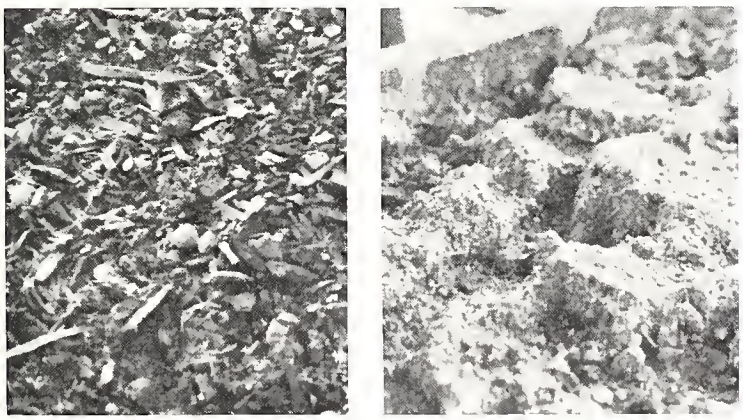


(*Top*) Rainfall is simulated inside this 32-foot drop tower on the University South Farm. (Fig. 1)

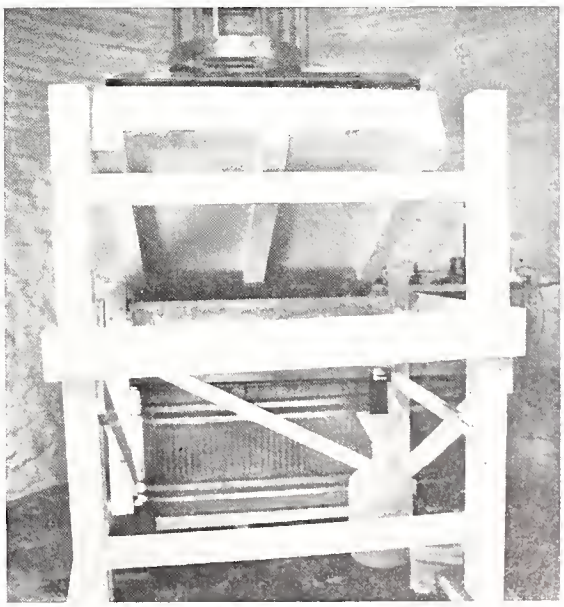


(*Right*) Inside the tower, looking down on the soil box. Holes in the box provide an outlet for water moving through the soil profile. (Fig. 2)

Inside the tower, looking up at the rain head. Part of the soil box is shown at right. (Fig. 4)



At left a bark mulch applied at the rate of 30 cubic yards per acre on a 3:1 slope suffered very little erosion after a 6-inch-per-hour rainfall that lasted 30 minutes. At right a sawdust mulch applied at the same rate on the same slope was severely eroded. (Fig. 3)



The soil box as seen from the back. Bottle collects water that percolates through the soil. Behind the bottle, a horse trough has been converted into a tank to collect the runoff. (Fig. 5)

Municipal Sludge in Swine Manure Helps Control Odor

J. L. ROLL, D. L. DAY, and B. A. JONES, JR.

ANAEROBIC digesters have long been used to treat municipal and industrial sewage. Methane gas, a by-product of anaerobic fermentation, is often utilized as an energy supply for the sewage treatment plant. But disposal of the remaining stabilized digester sludge is a major concern.

A partial solution to this problem may be found in taking care of still another problem — that of the odors that result when liquid manure is collected in confinement buildings. Manure in a well-developed anaerobic state is known to produce a relatively innocuous sludge along with methane and carbon dioxide, which are odorless gases. It was therefore reasoned that adding sludge from a municipal anaerobic digester to a liquid manure pit might have a "seeding" effect that would help to start and maintain anaerobic action in the pit and thus reduce odors.

Three trials

A study was undertaken to determine whether the addition of fresh non-lagooned municipal digester sludge to liquid swine manure would indeed help to initiate anaerobic activity and control odors. Three trials were conducted, with five digesters in each trial. Trials I and II were batch digestion tests, with the digesters being loaded and allowed to run 2 weeks with no addition or removal of material. Trial III was a 45-day study in which 1 liter of digester contents was removed each day and 1 liter of new material was added.

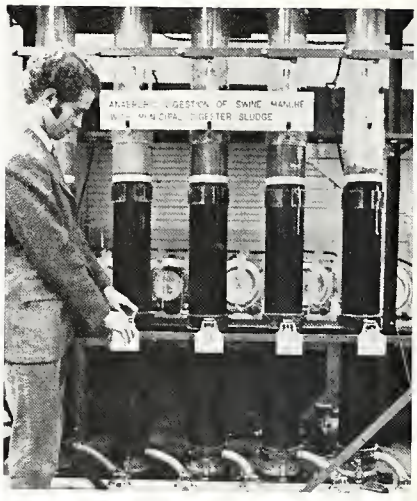
In all trials, the five digesters contained the following ratios (on a volume basis) of liquid swine manure to municipal digester sludge: 2:1, 1:1, 1:2, 1:5, and 1:10.

Anaerobic digestion was excellent in every trial. Values for oxidation reduction potential (ORP), pH, and organic acids were within the accepted ranges for well-developed anaerobic activity. The average ORP of the digesters was always less than −387 millivolts, pH of the digesters was always within 6.6 to 7.6, and organic acid concentrations never exceeded 720 milligrams per liter (as acetic acid) in any digester.

Digesters with 2:1 and 1:1 manure to sludge exhibited the best chemical oxygen demand (COD) and volatile solids reduction, while the digesters with 1:5 and 1:10 manure to sludge exhibited the least COD and volatile solids reduction. COD reduction ranged from 46.8 to 23.3 percent after 14 days for Trial I, 42.9 to 21.3 percent after 14 days for Trial II, and 56.0 to 11.5 percent after 44 days for Trial III. Volatile solids reduction ranged from 35.4 to 10.9 percent after 13 days for Trial I and 59.4 to 19.9 percent after 44 days for Trial III.

The gas produced by the digesters during Trial III suggested that excellent anaerobic conditions were present in each digester. The digester with 2:1 manure to sludge gave an average gas composition of 71.1 percent methane and 27.1 percent carbon dioxide. The other digesters, with 1:1, 1:2, 1:5, and 1:10 manure to sludge, yielded 68.6, 67.8, 67.9, and 67.0 percent methane, respectively. Yields of carbon dioxide were 29.0, 29.6, 30.2, and 30.7 percent. The manure was more readily degraded than the sludge in the study. Gas production per pound of solids destroyed varied from 20 cubic feet with a 2:1 manure to sludge ratio, to 12 cubic feet for a 1:10 ratio.

A "sniffing" panel of five members was asked to compare the odors of samples from the various digesters.



A sample of slurry is removed from a laboratory digester for odor evaluation.

This was done once or twice a week throughout the experiments. The panel found that the digester with 1:5 manure to sludge had the least offensive odor. The digester with 2:1 manure to sludge was most offensive, and the 1:1 digester was second most offensive.

Trade-off may be necessary

The digester sludge was valuable in setting up good anaerobic activity in manure, with the result that odor was controlled and the manure was more rapidly degraded. However, the best degradation was observed in the digester with the most odor, so a trade-off may be required. If good solids reduction is desired, some odor would have to be tolerated. Or the problem could be solved by using a closed digester for the manure.

At the levels of digester sludge added in this study, the odors from the digester were always less objectionable than those from the manure by itself. So adding digester sludge to a holding pit may help control odors and aid in stabilizing the manure. However, if you want to try this method of treating manure on your farm, first check state and local regulations about handling municipal sludge.

J. L. Roll is a former research assistant; D. L. Day and B. A. Jones, Jr., are professors of agricultural engineering. This article is based on Mr. Roll's M.S. thesis.

Five Faculty Members Are Honored

Five College of Agriculture staff members were honored March 1 in the fourth annual Paul A. Funk Recognition Program. Under this program, cash awards are provided by the Paul A. Funk Foundation of Bloomington "to recognize outstanding performance and high achievement among the faculty of the College of Agriculture at the University of Illinois."

The award winners are listed below, along with brief summaries of their major achievements.

Philip John Dziuk

An internationally prominent scholar, Dr. Dziuk has directed an innovative research program in reproductive physiology.

His pioneering studies of artificial insemination of swine have been useful both to other researchers and to swine producers. These studies have included evaluation of the effects of various diluents and storage on boar semen. He has also studied the effects of drugs on the boar's reproductive performance.

Other studies have concerned ovarian functions in gilts and the control of estrus with hormones. To elucidate factors involved in the control of pregnancy in swine, he has developed surgical techniques for studying early stages of fertilization and ova transfer. Recently he adapted an electronic device for diagnosing early pregnancy in pigs.

In addition to his work with swine, he has conducted research on methods of controlling ovulation in sheep and beef cattle.

James Forrest Evans

Through his research and teaching, Dr. Evans has established new standards for professional excellence in agricultural communications. He has also been a leader in enhancing public understanding of agriculture.

Twelve years ago he headed a new undergraduate agricultural communications program with nine student majors and two courses. Today the program has attracted 65 majors and includes nine courses.

Every year Dr. Evans receives consistently high ratings from his students. He was named "Outstanding University Instructor" in 1965 and "Outstanding Instructor in the College of Agriculture" in 1966.

His research activities have included 16 studies of the ways in which Illinois farm families receive and understand Extension information. In 1972 he received the award for the best paper in the Journal of the National Association of Colleges and Teachers of Agriculture.

Richard Harry Hageman

Dr. Hageman is an agronomist and biochemist who has meshed the two disciplines superbly in his studies of plant growth and yield.

His thesis is that crop productivity is based in the plants' physiological and biological properties. The importance of nitrogen fertilization in attaining maximum grain yields led him to investigate the metabolic assimilation of nitrogen. He conducted extensive research to characterize the enzymes involved, and was the first to detect nitrite reductase in higher plants.

He showed that corn inbreds vary in capacity to assimilate nitrate and that this variation is amplified by hybridization. He then hypothesized that nitrate reductase assays of inbreds and their progeny would provide a tool for selecting superior hybrids and varieties. So far, his hypothesis has been only partially validated; but agronomists now generally recognize the possibility of breeding for enzyme content.

Alvin Irvin Nelson

Professor Nelson's research on food processing has contributed immensely to human nutrition. He developed the original concepts of flexible film packaging of heat-processed foods and has done basic research on dehydration of vegetables as well as on many other problems.

The most recent accomplishment of Professor Nelson and his associates was to develop foods from whole soybeans. The salient feature of this work was the development of a soybean beverage base which can be further processed into spreads, desserts, and other foods. Professor Nelson's brilliant contribution was solubilizing the heat-denatured protein into a colloidally stable emulsion. The resulting products taste delicious and provide a low-cost source of protein.

Results of the work on soybeans will be felt for many years in increased markets for Illinois soybeans and improved protein nutrition in developing countries.

Jay Arthur Weber

More than anyone else in the United States, Professor Weber has persuaded engineers, service personnel, and equipment users to work together in solving the problems of applying mechanical energy to agricultural production.

He has sprearheaded research to make tractor maintenance easier and more effective, improve part-load efficiency, extend intake and exhaust valve life, evaluate engine modifications, and develop a dry-type air cleaner. This air cleaner, now standard equipment on tractors, eliminates one engine overhaul per tractor life. The resultant savings amount to 3 million dollars a year for Illinois farmers alone.

In recent years Professor Weber's work has expanded to include research on the application of power to soil for tillage and earthmoving. His work with graduate students in identifying soil parameters and applying model theory to the behavior of soil-machine systems has gained worldwide attention.

FARM BUSINESS TRENDS

THE FACT that the United States is the world's largest exporter of agricultural products has been widely publicized. The fact that we are also a major importer of food is much less well known.

This situation was illustrated recently when a student read that the United States uses about a "third of the world's energy," then asked, "Do we also feed a third of the world's population?"

A review of population and food supply figures shows that the United States produces food for less than 6 percent of the world population, and most of those people live in our own country.

Population experts estimate that world population at mid-1973 totaled about 3,860 million persons. U.S. population was about 210 million, or 5.4 percent of the total.

During much of the 1960's the United States imported about as much food as it exported. For the decade as a whole we exported slightly more than 13 percent of our food production, and imported a little less than 13 percent of our food requirements. As recently as 1971 imports of food were almost as great as exports (see chart).

Poor crops in many countries in 1972 greatly stimulated the demand for our wheat, soybeans, corn, and other food products. Exports took 17 percent of our food production in 1972, and about 19 percent in 1973. We continued to import about 13 percent of our food requirements.

(The above percentage figures are based on values of products calculated at the average prices for each product that prevailed during the three years 1957-59.)

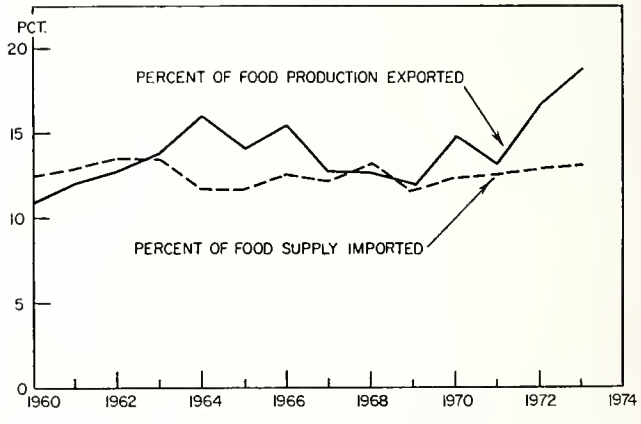
The leading food imports are meats, coffee, and sugar. Other important imports are cheese and other dairy products, wines, vegetables, cattle, bananas, fruits, cocoa, and nuts.

Most of the meat that is imported is beef from Australia and New Zealand. It is used mainly for hamburger and other ground-beef products. Meat imports during 1973 totaled about 2.6 billion pounds (carcass weight equivalent), and was equal to about 7 percent of our domestic production. We import processing beef because our output falls far short of consumer demand for this product.

In contrast, our cattle industry produces an excess of several animal products, notably hides, tallow, and variety meats (edible internal organs). Exports of meats and other animal products have been running at an annual rate of about $1.6 billion, more than half the value of imports of animal products.

About 69 percent of the sugar that we use is imported. The leading supplier is the Philippine Republic, but we also buy sugar from many other countries.

The value of all food imported during 1973 exceeded $4 billion; the value of food exported was about $6.5 billion. Total food consumed in the United States was valued at about $31 billion. — *L. H. Simerl, Professor of Agricultural Economics*



Percent of food production exported, compared with percent of food supply imported, 1960-1973.

University of Illinois at Urbana-Champaign
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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSU

More facilities are need to care for children wh parents work (page 8).

COLLEGE OF AGRICULTURE Volume 16, Number 3

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

(Cover picture by Stanley Weir)

Summer, 1974 Volume 16, Number 3

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POLICY ON RELEASE OF COMPUTER MODELS

OUTSIDE AGENCIES frequently ask to use computer models developed by Station scientists. A policy as to release of the models has recently been generated in the Station and approved by the faculty research policy committee.

If papers on the development and use of computer models have been published, then the models may be released to the general public, either at no cost or at a nominal cost.

If papers on the models have not been published, the models may be supplied to research workers only at *nonprofit educational institutions,* again free of charge or for a nominal fee. However, the recipients must agree to the following conditions:

1. The model is to be used for research purposes only and is not to be released to any other party.

2. Any publications or release of data generated from the models will acknowledge the Illinois Agricultural Experiment Station as the developer of the model.

3. Any modifications made in the model will be clearly identified in papers and published reports.

By releasing these research tools in an orderly way, we can cooperate with scientists at other institutions and still protect the scientists at the Illinois Station. — *G. W. Salisbury*

Cell-Free Agriculture: Fiction or Reality?

CONSTANTIN REBEIZ

"A theory is the more impressive the greater is the simplicity of its premises, the more different are the kinds of things it relates and the more extended is its range of applicability. Therefore, the deep impression which classical thermodynamics made upon me. It is the only physical theory of universal content, . . . I am convinced, that within the framework of applicability of its basic concepts will never be overthrown."—A. Einstein

The increasing seriousness of the energy crisis is bound to affect many facets of traditional human endeavor. Nature has rudely and abruptly reminded us that as humans and the major consumers of energy on the planet earth, we must live within the confines and consequences of the basic laws of thermodynamics.

To put it simply, energy cannot be created or destroyed, but must be transformed from one form to another. The traditional sources of energy — finite deposits of fossil fuels — are being rapidly depleted. We must therefore seek and develop alternate sources of energy to protect the development and continuity of our civilization.

The most abundant as well as the cleanest source of energy known to man is the sun. For millenia, humans have used plants to convert solar energy, carbon dioxide, and water into chemical energy, via the process of photosynthesis. Indeed our organic world is completely dependent on solar energy for survival. Without the sun, all life would disappear from the surface of this planet by gradual carbon starvation.

Despite striking increases in yield, modern agriculture has remained essentially conventional in its utilization of solar energy. The ultimate transducers of that energy into chemical energy are whole plants that remain essentially under their own nuclear-cytoplasmic regulatory processes. Humans exert only an indirect and partial control over these processes and their end product of food.

But conventional agriculture may become prohibitive in cost for future generations, as well as inadequate for their needs. Among the reasons for this rather gloomy prediction are the built-in limitations of whole plants, the heavy demand on fossil fuels for high agricultural yields, the limited availability of arable land, the environmental restraints on modern practices, and weather uncertainties.

Fortunately, recent advances in the life and physical sciences may ultimately free us from our dependence on conventional agriculture. One alternative, which we are currently exploring, is cell-free agriculture.

What is cell-free agriculture?

We define cell-free agriculture as the massive production of food by man-made photosynthetic membranes in the absence of cellular entities and without nuclear cytoplasmic control and interference. These membranes, which are the heart of the system, are envisioned as being highly specialized structures tailored to meet three well-defined, limited goals: self maintenance, self perpetuation, and high photosynthetic rates.

The highly specialized molecular architecture and limited tasks assigned to these membrane populations are expected to result in very high food-making capacities. Because the energy output of the system would not be siphoned away into making leaves, stems, and roots, it would be more efficient than natural photosynthesis. The performance and biological status of the membrane population would be under constant computer monitoring and control.

Feasibility

Theoretically, cell-free agriculture seems an ideal way of tapping the sun's energy, but is it feasible? The ultimate answer to this question lies in a thorough understanding of green cells — so thorough that man can substitute his control for cytoplasmic nuclear functions and can duplicate nature's action in a test tube.

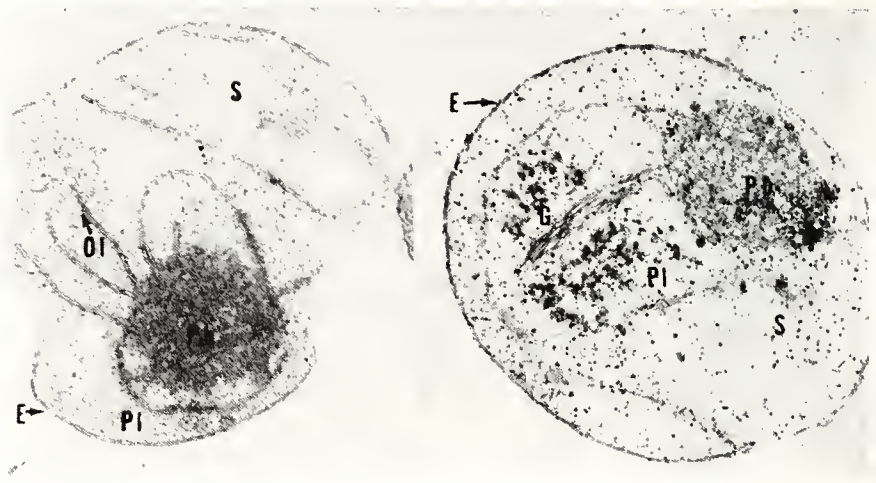
With this in mind, one wonders whether the green cell is the only effective photosynthetic entity handed down to us by millenia of slow evolution. Can man explode the myth of the cell and conquer its components as he conquered gravity and the atom? Can man release some primitive biological forces encapsulated by years of evolution that have allowed the plant to survive in an unpredictable and harsh environment? If the answer is yes, we ought to know how this can be done: if no, we ought to know why, so that we

Constantin Rebeiz is associate professor of plant physiology in horticulture.

may understand our future limitations.

At least seven areas of research must be thoroughly explored before cell-free agriculture becomes a reality:

1. The biosynthesis of chlorophyll.
2. The biosynthesis of photosynthetic membranes.
3. The extent and nature of repair needed to keep photosynthetic membrane populations functional for prolonged periods.
4. The reproductive requirements of these membranes.
5. A better understanding of the molecular architecture of photosynthetic membranes and a deeper understanding of the photosynthetic process to allow the bioengineering of more efficient structures.
6. Output recovery systems from the membrane populations — that is, food recovery without destruction of the membranes.
7. The adaptation of computer technology to such populations so that the system can be kept under constant observation and control.



In the right-hand picture "G" signifies the grana which are the photosynthetic membranes assembled in the test tube without nuclear cytoplasmic control. The basic materials in both pictures are etioplasts extracted from cucumber cotyledons or seed leaves. The etioplast at left has been irradiated for 2½ hours; the one at right has been incubated for 16 hours after 2½ hours of irradiation. (E, envelope; OL, overlapping of membranes in peripheral lamellae; PB, prolamellor body, crystalline or reacted; PL, peripheral lamellae; S, stroma.)

What has been accomplished

Although we do not now understand the biology of green cells enough to implement cell-free agriculture, rather encouraging advances have been made in the areas of research listed above.

Chlorophyll and most of the intermediates of its biosynthetic pathway have already been synthesized in cell-free systems in our laboratory. The step-by-step elucidation of how this molecule is exactly assembled in nature is now possible. It is under intensive study in cell-free models. The knowledge so far derived has allowed us to duplicate in a test tube nature's action in the development of this molecule.

Likewise, we have achieved a modest but significant degree of photosynthetic membrane assembly (grana) in a test tube without nuclear cytoplasmic control (see illustration). We are now investigating a complex synthetic medium that simulates, to a certain extent, the cytoplasm of the cell and allows the membrane assembly to proceed at higher rates and for longer periods than in our initial experiments. It is anticipated that this system will provide valuable insight into how proteins, lipids, pigments, and other accessories of the photosynthetic machinery are integrated into a functional unit. We hope it will deepen our understanding of the maintenance, reproductive, nutritional, and developmental requirements of the assembled membranes.

Although output recovery systems are still in the planning stage, they now constitute a reasonable problem to attack.

Division of the photosynthetic apparatus in a test tube was reported by a British laboratory in 1969. This is a promising beginning, although much remains to be done in the area.

Many laboratories around the world have committed important resources for a better understanding of the photosynthetic process and its regulation. Indeed, photosynthetic research has made spectacular advances in the past 30 years. A photosynthetic rate as high as 60 percent of that of whole plants can now be achieved by isolated chloroplasts for limited periods. Future advances in this area are bound to be based on a better understanding of the molecular architecture of the transducing membranes, and a better maintenance of the structures.

Finally, computer technology is now so advanced that no serious obstacles are foreseen in the constant monitoring of a functional cell-free agricultural system. We have already defined measurable parameters that could act as excellent indicators of the health of photosynthetic membranes maintained outside the cell.

A promising future

It now appears that the components of a cell-free agricultural system are at hand. The problem is no longer a qualitative one, but a quantitative one. As a legitimate field of research, it appears as justifiable as thermonuclear fusion.

The task of integrating the various components into a viable whole is still an immensely complex one studded with many challenges. This field of research, so relevant to the needs of society, should thus prove an exciting forum for interdisciplinary effort in the next few decades. Biologists, chemists, physicists, and engineers should find in it a rewarding opportunity to help humanity solve a pressing problem. Once more yesterday's fiction may prove to be tomorrow's science.

Lead Poisoning From the Environment?

G. L. ROLFE and D. E. KOEPPE

SINCE THE beginnings of the industrial revolution, factories have been spewing lead into the atmosphere. Now lead from the world's industries has been deposited over most of the earth's land surface.

With the addition of tetraethyl lead to gasoline some 50 years ago, even more lead has been pouring into the environment. Concentrations of 250 to 1,000 ppm or more have been measured in or on soils and vegetation near highways and in urban areas.

Is the lead in the environment dangerous to plants, to animals that eat the plants, and finally to people? Until recently, the answer to that has been no. There are few documented cases of lead poisoning in humans or in plants. However, it has been recognized for nearly half a century that lead is toxic to cellular and subcellular materials in the test tube. A myriad of enzymes are now known to be inhibited by lead ions. And, according to recent research at the University of Illinois, there may be danger from present high levels, depending on soil characteristics and other environmental factors.

Four teams study the problem

The possible impact of continued lead additions to our rural and urban environment is the subject of an interdisciplinary study at the University of Illinois. This project, which is directed through the Institute for Environmental Studies, involves scientists from a number of departments across the entire campus. Included are the Departments of Forestry and Agronomy in the College of Agriculture.

At present, the interdisciplinary group is divided into four teams:

1. An ecosystem study team of plant and animal ecologists. This group is monitoring two areas: most of the urban area of Urbana-Champaign, and an agricultural area north of these cities. The function of the group is to determine lead input and output and the sites of greatest lead concentration in the ecosystem.

2. A laboratory-greenhouse study team of soil scientists (physical, chemical, and microbial), plant physiologists, and analytical chemists. Goals of this group are to determine the specific sites of lead binding within soils and plants, the mechanisms by which lead moves from one place to another within the ecosystem, the uptake of lead by plants and animals, and finally the effect of lead on living organisms.

3. A modeling team. This team designs sampling methods, analyzes and synthesizes data, and develops models. The synthesized data and models will be used in predicting the effects that continued emission of lead into the environment will probably have on plant growth and yield.

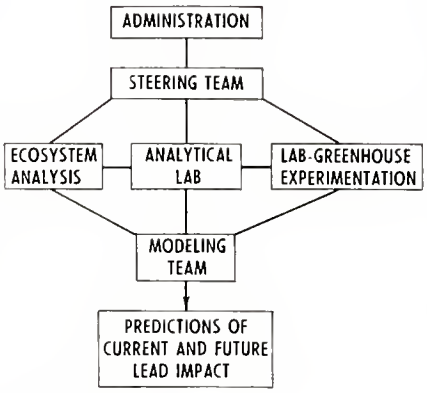
4. An analytical laboratory team. By doing the chemical analyses of samples from field and laboratory experiments, this group supports the ecosystem and laboratory-greenhouse teams.

Team leaders from these four groups make up a steering team, with overall responsibility for the project.

Interdisciplinary effort necessary

The interdisciplinary approach to the problem of lead in the environment is typical of many current research projects. In the past, researchers tended to more or less mind their own business, paying little attention to research that was very far afield from their own. But now problems are often too complicated to be solved by research in one subject matter area alone.

Many of today's complex questions concern the environment. Local, state, and federal legislative bodies, as well as the Environmental Protection Agency, need answers to these questions so that adequate legislation to safeguard the environment can be passed.



Organization of task force.

Consulting or other research firms generally do not have the expertise and resources to conduct the needed research. Large universities, however, do have the trained personnel and the necessary facilities. Many professors in the College of Agriculture, as well as in other colleges, are engaging in interdisciplinary research on environmental problems.

Results thus far

As for the study of lead in the environment, our data thus far indicate that lead input into the ecosystem far exceeds the output. Soils, plants, and stream bottom sediments are the major sites of concentration. When the entire ecosystem is considered, most of the lead is deposited in urban areas and near major highways in rural areas.

The lead build-up is greatest in urban areas and along highways. A picture is taking place which suggests that the lead, particularly in light, sandy soils, could become toxic to organisms in the future. At present, however, it is fairly safe to say that in most rural areas lead poisoning of plants and animals is not yet a serious problem.

G. L. Rolfe is assistant professor of forestry; D. E. Koeppe is associate professor of plant physiology in agronomy and forestry.

Soybeans' Role in Nitrogen Balance

Even though soybeans fix nitrogen from air, they also remove nitrogen from soil

J. W. JOHNSON, L. F. WELCH, and L. T. KURTZ

SOYBEANS can get their nitrogen from three possible sources: natural soil materials, fertilizer nitrogen, and nitrogen fixed from the air.

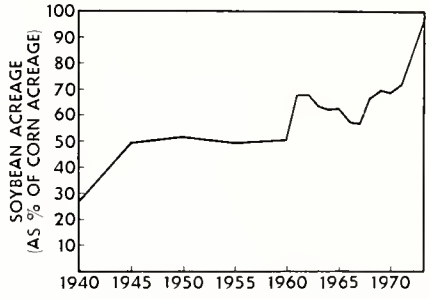
Since soybeans are a legume, their roots contain nitrogen-fixing bacteria. Nitrogen in the air is changed by the bacteria-soybean association into a form that the plants can utilize. The relationship between the bacteria and the soybean plant is symbiotic; that is, both benefit from the association. The bacteria use photosynthetic products manufactured by the plant, and the plant has access to nitrogen that would not be usable without the bacteria.

The nitrogen-fixing bacteria work only as hard as they need to. As the fertilizer nitrogen available to the soybeans increases, the amount of symbiotically fixed nitrogen decreases.

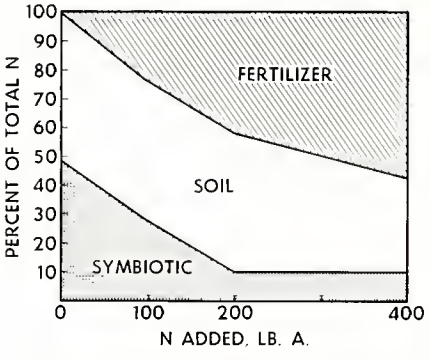
The fluctuations in symbiotically fixed nitrogen were observed in a recent study aimed at determining the proportion of nitrogen used from each of the possible sources. We wanted the information so we could evaluate the possible effect of soybeans in a nitrogen balance scheme for Illinois. The balance between added and removed nitrogen is important because of the potential effect of excessive nitrogen on water quality.

Large soybean acreage

For many years corn has occupied a larger acreage than any other crop in Illinois, but soybean acreage is catching up (Fig. 1). In 1940, only 27 percent as much land was planted to soybeans as to corn. Since 1969, soybean acreage has been 70 percent or more of corn acreage. And in 1973, soybean acreage was about 95 percent of corn acreage (9,230,000 acres of soybeans; 9,670,000 acres of corn).



Soybean acreage expressed as percent of corn acreage in Illinois. (Fig. 1)

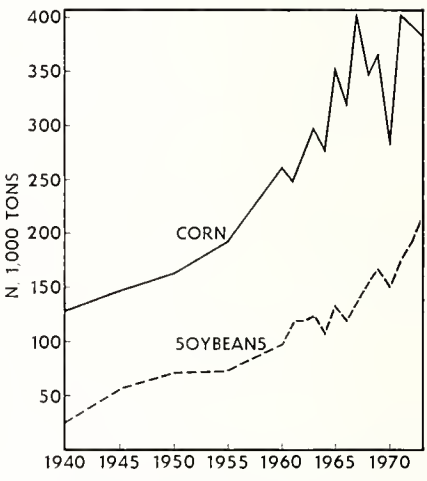


Percent of total nitrogen in soybeans derived from symbiotic, soil, and fertilizer sources, as affected by rate of fertilizer nitrogen. (Fig. 2)

Soybeans and corn are often grown in alternate years on a given land area. Corn generally receives fertilizer nitrogen but soybeans do not. The amount of nitrogen fertilizer needed in Illinois would greatly increase if all the soybean acreage were also planted to corn.

Use of different sources

To determine the amounts of nitrogen in the plant that come from the soil and from the air, we grew soybeans with and without symbiotically fixed nitrogen. (This was possible because plant breeders have produced some soybeans in which nitrogen-fixing bacteria are not active.) On some plots, we applied fertilizer nitrogen. It had been labeled so that we could distinguish it from nitrogen already in the soil and from symbiotically fixed nitrogen in the plant.



Net removal of nitrogen by soybeans and corn in Illinois. (Net removal by soybeans was calculated as 37 percent of total nitrogen in the grain.) (Fig. 3)

Without fertilizer nitrogen, symbiotically fixed nitrogen provided 48 percent of the nitrogen used by soybeans; the soil provided 52 percent (Fig. 2). With fertilizer nitrogen, symbiotically fixed nitrogen decreased as the rate of application increased. Fixed nitrogen accounted for only 10 percent of the total nitrogen in soybeans when 200 and 400 pounds of fertilizer per acre were added. Nitrogen used from the soil's supply also decreased as fertilizer rate increased.

Fertilizer nitrogen merely changed the amounts of nitrogen used from

J. W. Johnson is associate agronomist; L. F. Welch and L. T. Kurtz are professors of soil fertility, Department of Agronomy.

different sources. As shown by the following figures, it did not appreciably increase the total amount of nitrogen in the above-ground soybean plant; nor did it increase yield.

Fertilizer N, lb./A.	*N in plants, lb./A.*	*Yield, bu./A.*
0	192	42
100	203	42
200	188	41
400	203	44

The data indicate that nitrogen is symbiotically fixed only if it is needed by the soybeans. The nitrogen-fixing bacteria are active when soil nitrogen is low — relatively inactive when soil nitrogen is high. Thus, the bacteria-soybean complex does not add excessive amounts of unused nitrogen to the environment. Also, nitrogen added for corn but not removed by the corn will be removed by soybeans.

Net removal of nitrogen

Net removal of nitrogen from the soil is equal to total nitrogen in harvested soybean grain minus nitrogen symbiotically fixed. In our study, 76 percent of the nitrogen in the above-ground soybean plant was in the grain and 24 percent in the stover. Symbiotic fixation accounted for 48 percent of total nitrogen when no fertilizer nitrogen was added. Net removal of nitrogen from the soil was 76 percent minus 48 percent, or 28 percent of above-ground plant nitrogen. Net removal of nitrogen from soil was equal to 37 percent of the nitrogen in the grain ($28/76 \times 100 = 37$ percent).

We used the 37 percent value to calculate net removal of nitrogen from the soil, having first estimated total nitrogen in harvested soybeans from soybeans produced and nitrogen content per bushel. Because corn is the big remover of nitrogen from Illinois soils, the nitrogen removed by corn grain is compared with net removal of nitrogen by soybeans in Figure 3. In 1940, when soybeans removed 26,000 tons of nitrogen and corn removed 127,000 tons, soybeans' removal was 20 percent as great as corn's. By 1973, net removal by soybeans was 215,000 tons of nitrogen, or 56 percent as much as corn (383,000 tons).

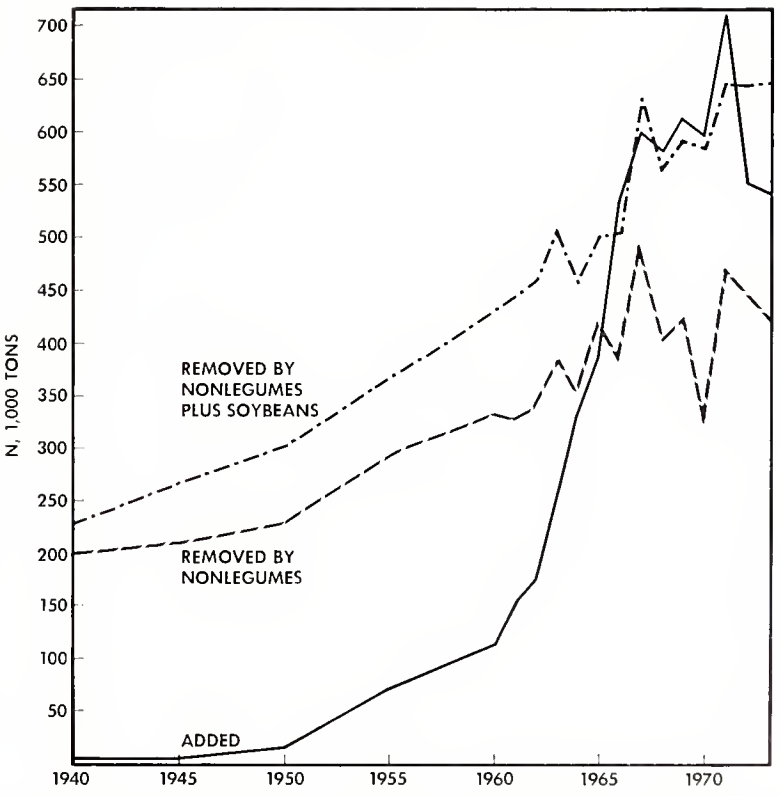
Net removal of nitrogen per bushel is greater for soybeans (1.48 pounds) than for corn (0.77 pound). However, corn generally yields more bushels per acre than soybeans. On the basis of average yields for Illinois in 1971-1973, corn grain removed 33 pounds more nitrogen per acre than did soybeans (corn, 82; soybeans, 49).

In 1973 net removal of nitrogen by soybeans was equivalent to 39 percent of all the fertilizer nitrogen applied in Illinois that year. At the same time, soybeans symbiotically fixed 367,000 tons of nitrogen — equal to 67 percent of all fertilizer nitrogen.

Nitrogen balance

Welch earlier reported the relation between nitrogen added as fertilizer and nitrogen removed by nonleguminous crops (Illinois Research, 14:1). He assumed that no net change occurred in soil nitrogen when soybeans were grown. From the present study, it is apparent that this assumption was not valid. Another study by Boone and Welch (Illinois Research, 14:4) indicated that corn grain in Illinois contains 0.77 pound of nitrogen per bushel rather than the 0.90 pound that Welch used in his original calculations. Using this new information, added and removed nitrogen for Illinois since 1940 are shown in Figure 4.

Inclusion of net removal by soybeans increases considerably the amount of nitrogen removed in the harvested portion of agronomic crops. In every year except 1966, 1968, 1969, 1970, and 1971, nitrogen removed by nonlegumes plus net removal by soybeans has exceeded nitrogen added. In 1970, added nitrogen exceeded removal by about 110,000 tons. This is attributable primarily to the low corn yield caused by leaf blight that year. Removed nitrogen exceeded added nitrogen by 91,000 tons in 1972 and by 98,000 tons in 1973.



Nitrogen added as fertilizer, that removed by nonlegumes, and that removed by nonlegumes plus net removal by soybeans in Illinois. (Fig. 4)

More and Better Day Care Needed In Illinois

MARY WEIR

DAY CARE of infants and children is one way of helping families to maintain their home life. The children receive care outside their homes during the parents' working hours, then return home when the parents are there to care for them.

Centers and homes providing day care are licensed by the Illinois Department of Children and Family Service (DCFS). According to the Child Care Act of 1969, a home is a facility caring for fewer than eight children; a center accommodates eight or more. The care may be for all or part of a day or a night.

In October, 1973, 4,639 day care homes and 1,892 day care centers were licensed in the state. Their total capacity was about 95,000 (17,351 in day care homes; 77,497 in centers). However, this is only a fraction of what is needed. According to the 1970 Census, about 950,000 children under thirteen years of age have mothers who work outside the home at least part of the time.

Most available day care is for children aged three to five. Although facilities for this group are still inadequate, the greatest lack is in facilities for children under three and over five.

Before adequate day care can be provided, a number of problems must be solved. In general, these problems center around the reactions and needs — and frustrations — of four groups: owner-directors of day care facilities, licensing representatives, teachers, and parents.

Owner-directors

People wanting to provide care must often fight vigorously for permission. First, the minimum standards of the DCFS must be met. Then, the owner-director of a day care center must comply with local zoning, health, fire, building, sanitation, and environmental ordinances, all of which may vary from place to place.

To further complicate the problem, licensing representatives from DCFS vary in their interpretations of minimum standards, and inspectors from the various regulatory offices are also likely to differ in their interpretation of the rules. So the future owner-director is faced with a myriad of people from a large number of offices, who may at times give contradictory information.

Many day care centers and nursery schools that are privately owned and run for profit are identified as businesses and are permitted only in districts zoned for business. This rule often forces the owner-director to establish a facility in an area that is less than desirable for children or that is inconvenient for parents to reach.

Licensing representatives

The uneven interpretations of DCFS standards by licensing representatives may be due to individual bias, inexperience, or insufficient training in child development.

Individual biases are based on personal attitudes about what is good for a child regardless of what the written standards say. Sometimes a bias reflects the differing positions of child-training "experts." These positions range from support of a didactic teaching style and tightly organized schedules, to belief in a discovery-exploratory style of teaching within a flexible organization.

As DCFS standards are now written, they can be interpreted in either of the two directions. They are currently being revised so that they will be less subject to interpretive bias. This is a difficult task. It is easy to specify physical facilities. However, such things as discipline, programs, and personnel qualifications will probably never be defined to the satisfaction of all who use or are affected by the standards.

In the past, the DCFS has often been unwilling to go through the process of closing centers that licensing representatives have identified as operating without a license or below minimum standards. This has led some representatives to feel that there is little use in trying because they have no back-up support. Conflicting and changing policies as to whether a representative can visit a facility without an appointment further aggravate the situation.

Current reorganization within DCFS purports to correct these problems. Eventually the reorganization may have some positive effects, but in the meanwhile it is producing strong feelings of anxiety in some licensing representatives.

Staffing patterns are being reorganized and job descriptions have been redefined. Some licensing responsibilities have been expanded to include facilities other than day care. Regions have been reorganized into areas, boundaries have been changed, personnel has been shifted, and local offices have been decentralized. No overall plan fully explaining these changes has been communicated to licensing representatives. They rely on rumor and after-the-fact events. Their supervisors, some of them new, are often uninformed about their own functions as well as the representatives' role.

This is compounded by an attempt, at least in the Chicago area, to separate licensing and consultation, which in the past have usually been practiced by one person, the licensing representative. Many representatives do not believe it is desirable or efficient to separate the two functions. Facilities must be helped not only to meet minimum standards, but also to go beyond that minimum if the owner-director is willing. Accomplishing this goal depends on a

sound, trusting relationship with the owner-director, and this relationship can be best achieved by the licensing representative who makes the initial contact.

Some DCFS employees have responded to the total situation by forming unions. A recent executive order permitting state employees to organize has, to some extent, freed them from the fear of losing their jobs because of union activities.

Teachers' problems

The teachers and aides in day care centers are generally low-paid. Only recently has the Department of Labor begun to implement minimum wage laws for these employees. The rare exceptions of pay scales commensurate with local salaries for public school teachers are found in a few government-funded programs such as Head Start or some programs for handicapped children.

Combined with the low salary is the belief, generally held by the public and sometimes shared by the teachers themselves, that this type of work has a low status. Unfortunately women's liberation groups help to perpetuate this image. On the one hand they recognize that children need care and they advocate day care facilities; on the other hand they want to free individual women from the "tedious drudgery" of child care and housework. Unwittingly they do the workers in day care a disservice. Far better that they recognize the skill necessary for this kind of work and state that individuals need to make choices about their areas of expertise.

Many who work in day care do so under difficult conditions. Physical facilities are sometimes bleak and barren. Too many centers are housed in dull, dank basements with no windows, or with windows too high to look out of. Sometimes bathrooms and kitchens are so inconveniently located that a worker must either climb one or two flights of stairs innumerable times a day, or plan such a regimented program for the children that her relationship with them is strained.

Teachers are often isolated with a group of children for long periods. Most teachers eat lunch with the children, and many work an eight-hour day with scarcely a break. Boredom and fatigue combine to create teacher behavior that is not always good for the children or for the teacher's own self-image.

Teaching equipment and supplies are sometimes lacking in both quantity and quality. Good teachers spend hours beyond classroom time finding and planning for equipment with which they can implement their programs. Those who receive no help in obtaining proper supplies work day after day without adequate tools, and this means that they often have to follow practices that are not good for children or for themselves.

Because of the low pay and poor working conditions, a good number of sensitive and skilled workers are lost to the field. Many untrained persons are hired, including people with neuroses or biases that may affect the children or other staff. For example, I discovered that a woman with a phobia about dolls was working with infants. And another woman with a religious bias that put restrictions on her food handling was caring for infants and toddlers.

Parents' problems

Some parents may never get to use day care because the facility is not open during the hours of need, because it is too costly, or because it is located inconveniently. Hospital, restaurant, airport, and other workers who are on a swing or graveyard shift can often find no licensed care for their children. The parents may end up by leaving the child in the car in the parking lot, or at home alone or in the care of another young child. The fortunate families are those with a babysitter, neighbor, or relative to provide care.

Day care is expensive and, unless it is subsidized, only the middle and upper classes can afford it. The marginally poor — those who do not qualify for subsidies under minimum wage guidelines — are locked out.

The difficulty of dropping off children before going to work is complicated by the age limitations of most day care centers. A mother with an infant, a preschool child, and a school-aged child may have to make three different stops before getting to work. If she must be on the job by 7:30 a.m. and must rely on public transportation, she may have to leave home as early as 6 a.m. What this situation may mean in spent time and energy can be left to the imagination.

Many day care centers are strongly urging parental involvement in parent education meetings, classroom sessions, and policy-making bodies. However, parents in the type of situation just described have very little time for such involvement, and other parents may prefer to use their free time in different ways.

Some parents may have to use day care centers and homes where the philosophy of child rearing is quite different from the parents' ideas. The most frequent area of disagreement is probably discipline. Another area of disagreement sometimes occurs when young families adhere to certain food fads or diets not prescribed by a doctor. Day care centers, however, cannot provide meals that health authorities consider nutritionally unbalanced. In having to choose between no day care at all and day care that doesn't coincide with the parents' beliefs, many parents feel that their rights are being abridged.

Problems are studied

Some of the many problems facing day care in Illinois are receiving attention. Volunteer bodies such as the Statewide Day Care Advisory Committee and the Revision of Licensing Standards Committee are trying to provide some helpful directions. Professional and action groups such as the Illinois Association for the Education of Young Children, the Child Care Association, and the Chicago Day Care Crisis Council speak and act on behalf of children in day care. There are thus some who do care about these children; there is an urgent need for more.

Mary Weir is assistant professor of child development.

Foreign Private Investment Aids A Developing Country's Agriculture

JEAN M. DUE

Most developing countries face the problem of increasing foreign exchange earnings. A country can, of course, expand production of the traditional export crops, such as coffee, cocoa, rubber, tea, peanuts, and palm oil. But most of these products have a low income elasticity — that is, demand does not increase proportionately as income rises. Moreover, the fluctuations in world prices for primary agricultural products cause great uncertainty about the level of foreign exchange earnings. Hence planners and government administrators have been searching for new export products as well as trying to expand production for the domestic market.

Experiment in Senegal

Senegal, in West Africa, has recently been increasing its foreign exchange earnings by diversifying its agricultural exports. This undertaking is particularly noteworthy because it is being supported by private foreign investment. Most African countries since independence have discouraged private foreign development in the agricultural sector, although encouraging it in the industrial sector of the economy.

The capital for the crop diversification in Senegal is being provided by Bud Senegal, an international private corporation which is owned mostly by foreigners. Bud Holland owns 55 percent of the corporation; Bud California, 7 percent; and the Government of Senegal, 38 percent. Bud Holland is primarily a vegetable brokerage firm engaged in marketing vegetables in western Europe. Bud California has been producing and marketing vegetables in California.

Bud Senegal grows vegetables in Senegal and ships them to the European Common Market countries, mostly in winter. Some of the produce is sold on the domestic market, but this has not been the primary focus to date.

Development of Bud Senegal

The president of Bud Senegal is a German who, in the 1960's, saw the potential for marketing vegetables in Europe during the winter when prices are high. Senegal is ideally located to produce vegetables in winter, and is close enough to Europe that transportation is not a problem. If the natural advantages of Senegal could be combined with the marketing and production expertise of companies like Bud Holland and Bud California, the project of vegetable production and marketing appeared promising.

In 1967, Dr. Pearson of Cornell University was brought to Senegal to conduct vegetable variety trials and initiate a feasibility study. After a search by air for ideal soil conditions, a decision was made to locate the farm at Rusiqué, 40 kilometers from Dakar. The soil there is very similar to that in the Salinas Valley of California. In addition, Dakar has good airport and seaport facilities, housing, communications, and other urban advantages. The Senegalese government gave the firm a long-lease on the property and agreed to furnish water facilities for irrigation.

Growing and marketing crops

The company began production in 1972, on 150 hectares of leased land. In 1973, 375 hectares were planted. (A hectare is 2.471 acres.)

This year, in addition to the company-leased land, 500 additional hectares are being developed as an extension project to aid 500 smallholder farmers in the area. Bud Senegal is providing the technical assistance and the market for vegetables produced by the smallholders.

The major crop on the company-leased property is green beans. Other crops include lettuce, cabbage, peppers, onions, eggplant, tomatoes, cantaloupe, and gladiolas.

The Israeli drip method of irrigation, which uses 65 percent less water than overhead irrigation, is used. The main feeder lines are 4 inches under ground, permitting cultivation of the land above them. Plastic hoses connected to the feeder lines run through the rows of vegetables, and water drips from the hoses at a set hourly or daily rate. The hoses can be rolled up when one crop is finished and relaid when another has been planted. A simplified model of this system has been developed for the smallholder farmers, with water being stored in barrels.

Washing, grading, and packing are done on the farm. At first, the products were sent by ship to Mediterranean ports, but shipping services proved too irregular. Now the products are flown to Europe three times a week in winter and as needed during the rest of the year. At present the company ships by charter and commercial air freight flights from the Dakar airport, but it plans to develop its own airstrip for charter flights.

Personnel and investment

The expatriate management staff consists of seven persons from the Netherlands, U.S.A., Germany, and Israel. About 200 Senegalese are employed full time and many more part-time.

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Investment in Bud Senegal has been substantial: Houses, office buildings, water-storage tanks, and sheds for sorting, washing, and storing have been built; and 22 tractors plus other mechanical equipment, automobiles, and trucks have been purchased.

In 1974, a drouth year in Senegal, Bud Senegal bought over 200 cattle, which are being fed refuse from the vegetables. Most of these cattle are being fattened and marketed, while some are being kept for breeding stock.

(*Left*) Barrels hold water used for irrigation on smallholders' farms.

(*Below*) Cattle eat vegetable refuse on the Bud Senegal farm.

A successful enterprise

The operation appears to be running well. Last year, net revenue totaled over 35 million CFA francs (about $140,000).

The President of Senegal is very impressed with the success of Bud Senegal; it is one of his favorite showplaces for foreign visitors. Now the government is suggesting that Bud Senegal take over an additional 600 hectares, the site of an abandoned high-cost peanut enterprise developed by the French colonial administrators. The company is being asked to provide a tractor-hire service for surrounding farmers, as well as to use the land and equipment to grow crops. This year Bud Senegal is planting maize on the site; a feasibility study will be conducted to determine further interest.

A possible model?

With its success, Bud Senegal would seemingly provide a model for private foreign investment in the agriculture of other developing countries. The Senegalese government has furnished land, water rights, and some of the capital. The foreign investors have provided 62 percent of the capital, as well as production and marketing technology; and have selected the foreign and domestic staff. An enterprise has been developed that is a significant earner of foreign exchange and provides employment for 200 nationals full time and many others part time. The company is committed to including smallholder farmers in its development plans and providing the expertise that these farmers need.

Still, many developing countries hesitate to encourage private foreign investment in the agricultural sector of the economy. For their goal is not merely to increase production, foreign exchange earnings, and income. They also want to retain control of the economy (especially the land) and provide maximum employment opportunities and training for their nationals.

Presumably a government corporation, by borrowing capital from abroad, could develop the same type of enterprise as the foreign-dominated Bud Senegal. Presumably, too, the government would be more committed to training nationals in management techniques as well as in lower-level skills, and would include more smallholder farmers in the endeavor. A government corporation could also insist on more labor-intensive techniques of production.

However, a government corporation would often have to hire expatriates for some of its operations during the early stages of development. These expatriates would normally stay only two years and would not have the commitment that they would have to a private concern. Also, economic success might be slower with the government corporation, as it would lack the production-marketing mechanism of the private company.

On balance, a joint government-private corporation may provide a good model for development of both agriculture and industry if certain commitments are made: Nationals would be employed and trained. Profits would be reinvested within the country. The core area would be expanded to include smallholders, providing them with technical assistance and a guaranteed market for their products. The enterprise would be returned to national ownership (private or government) after a limited period of 10 to 15 years.

Low Milk Fat: Causes and Cures

R. B. RINDSIG and C. L. DAVIS

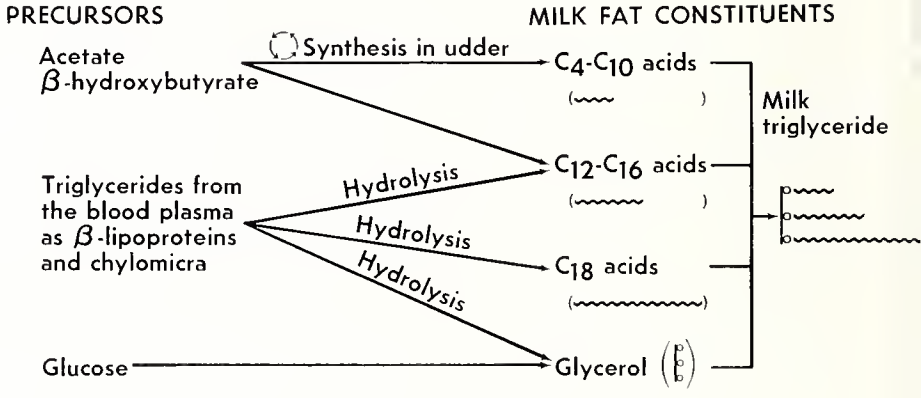
WHEN quality roughage is scarce or expensive, high-producing dairy cows may have to be fed extra grain. There is a limit, however, to the amount of grain that can replace roughage. Lactating cows require a minimum amount of roughage for best performance.

If the daily diet contains less than 1 pound of roughage and more than 3 pounds of grain per 100 pounds of body weight, the dairyman can look for some undesirable effects: (1) Total dry-matter intake may be reduced. (2) Maintaining a constant intake of feed may be more difficult. (3) The milk fat content is almost certain to decrease. For example, milk fat was recently found to be 3.21 percent on a normal ration (24 pounds of grain with free-choice hay). On a high-grain ration (35 pounds of grain, 5 pounds of hay), fat content dropped to 1.77 percent.

The drop in fat percentage significantly reduces the dairyman's profit because milk is sold partially on the basis of fat content. The low-fat milk phenomenon not only is economically important, but also presents a challenging problem in rumen and tissue metabolism. It has therefore been a topic of research here for a number of years.

Structure and composition of fat

In freshly secreted milk the fat is dispersed throughout the aqueous phase as minute globules. These globules are composed of an inner core of triglyceride surrounded by a complex layer of lipoproteins known as the fat globule membrane. Of the total lipid in milk, about 98 percent is made up of triglycerides and the remaining 2 percent consists of cholesterol esters, phospholipids, hydrocarbons, and carotenoids.



Origin of milk fat triglycerides.

A triglyceride is composed of a molecule of glycerol to which are attached three molecules of fatty acids. The fatty acid composition of milk fat triglycerides is the most complex of all naturally occurring fats. To date about 140 fatty acids have been identified in these triglycerides, but most of the fatty acids are present in only trace amounts.

The fatty acids in the triglycerides may be short-chain or long-chain, having as few as 2 carbon atoms or as many as 28. (Most, however, have 4 to 18 carbon atoms.) Further, the fatty acids may be classified into a number of broad groups, including saturated, unsaturated (*cis-* or *trans-*), branched, keto, hydroxy, or cyclic acid. The proportions of short- to long-chain, of saturated to unsaturated, and of *cis-* to *trans-* acids are important factors governing the physical properties of milk fat.

Synthesis of milk fat

Many experimental approaches have been used to elucidate the biochemical pathways of milk fat synthesis. As a result of these studies, it is now generally accepted that short-chain acids with 4 to 10 carbons (representing about 10 percent by weight) are synthesized in the mammary gland from acetate and β-hydroxybutyrate.

Long-chain acids with 18 carbon atoms (about 40 percent by weight) are derived from blood triglycerides contained in low-density β-lipoproteins and chylomicra (very small fat particles). Fatty acids intermediate in chain length (12 to 16 carbon atoms) may originate either in the mammary gland or in the blood plasma.

The formation of milk fat is illustrated in the above diagram.

Sources of milk fat precursors

The triglycerides that circulate in the chylomicra of the blood plasma come from dietary fat. This fat is hydrolyzed in the rumen and resynthesized into triglycerides in the intestinal wall.

Triglycerides are also produced in the liver, mainly from free fatty acids (FFA) from mobilized body fat. These triglycerides are attached to proteins and circulate as lipoproteins. It is believed that glycerol and fatty acids are released at the capillary wall in the mammary gland as a result of the action of the enzyme, lipoprotein lipase. The fatty acids are then used for milk fat synthesis.

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The blood acetate that is used for the synthesis of about 40 percent (by weight) of the milk fatty acids comes primarily from rumen fermentation. The ketone body, β-hydroxybutyrate, is formed from butyric acid in the rumen wall or from FFA in the liver.

Why low-fat milk?

Early studies of the low-fat milk problem in cows fed high-grain low-roughage diets showed that the molar ratio of acetate to propionate in the rumen always decreases markedly whenever milk fat content falls significantly. This is illustrated in the table below, showing results of an Illinois study.

These observations, together with conclusive evidence that acetate is an important substrate for fat synthesis in the mammary gland, supported a theory that reduced milk fat secretion is due to a deficiency of acetate. To test this theory, a study was instituted comparing the actual amounts of acetate produced in the rumens of cows fed a high-grain ration and of cows fed a normal ration.

Acetate production in rumen-fistulated cows was measured with an isotope dilution technique using radioactive acetate. Propylene glycol was used as a rumen volume marker. Mean acetate production for the high-grain diet was 28.1 moles per 24 hours as compared with 29.3 moles for the control diet. With this small a decrease, it was concluded that neither the reduced milk-fat content nor the changed acetate-propionate ratio is due to an absolute shortage of acetate.

A second study was undertaken to determine whether an increase in propionate rather than a decrease in acetate caused the change in the ratio. Again, an isotope dilution technique was used in rumen-fistulated cows. Radioactive propionate was added to the rumen along with propylene glycol as a rumen volume marker. The rumen microbial production of propionate was determined from dilution of the added radioactive propionate over an 8-hour period.

Effect of High-Grain Ration on Rumen Volatile Fatty Acids

Volatile fatty acid	Normal ration	High-grain ration
	molar pct.	
Acetic (2 carbon)	62.4	47.0
Propionic (3 carbon)	23.9	39.8
Butyric (4 carbon)	12.3	9.4
Valeric (5 carbon)	1.4	3.8
C_2/C_3 Ratio	2.6	1.2

Propionate production, which was 13.3 moles per day for the control diet, shot up to 31.0 moles for the high-grain diet. This result, coupled with the previous study, supports the theory that the change in the acetate-propionate ratio is due to an increase in propionate production.

In a third study, the possibility that a shortage of β-hydroxybutyrate may be a factor in decreasing milk fat was explored. Radioactive β-hydroxybutyrate was infused into cows on high-grain diets and cows on normal diets. The radioactive β-hydroxybutyrate in the milk fat was then measured.

The results showed that β-hydroxybutyrate contributes a maximum of 8 percent of the milk fatty acid carbon. Dietary treatment had no observable effect on the plasma concentrations of β-hydroxybutyrate, its entry rate, its oxidation to carbon dioxide, or its contribution to the total expired carbon dioxide. It was therefore concluded that a deficiency of β-hydroxybutyrate does not explain the low milk fat content of cows fed high-grain diets.

Research is now in progress to determine how elevated glucose levels affect milk fat. The *trans*-isomers of the long-chain fatty acids from blood plasma triglycerides are also being examined to determine what effect, if any, they have on milk fat synthesis.

Additives for high-grain diets

From a practical viewpoint, the limited quantities of available roughages often leave the dairyman with no alternative but to feed high levels of concentrates and low levels of roughage. We have therefore tried to find a grain additive that will maintain normal milk fat content when roughage is limited.

Twenty-eight lactating cows were used to study the effects of supplemental bicarbonates on rumen volatile fatty acids, milk production, and fat content of the milk when high-grain rations were fed. The bicarbonates (equal parts by weight of sodium and potassium) were incorporated into the grain mixtures at two levels — 1.5 and 3.0 percent. All cows received grain free choice plus 5 pounds of alfalfa hay per day.

When bicarbonates were fed at the 3-percent level, milk fat did not decrease after cows were put on a high-grain diet. Without bicarbonates, the percentage of fat in the milk dropped from 3.51 to 1.74 percent. For cows whose milk fat content had already dropped to 1.43 percent, feeding 3-percent bicarbonate increased fat content to 2.33 percent.

In a second trial, bicarbonates were incorporated into the grain mix at a level of 1.5 percent. Fat contents for normal, high-grain, and high-grain-plus-bicarbonate rations were 4.1, 3.1, and 3.6 percent, respectively.

On the basis of these two studies, about 1 pound of bicarbonate per cow per day appears to be necessary for greatest effect. However, this level of supplementation may cause some cows to refuse the feed.

In work by the senior author at Wisconsin, lactating cows were fed high-grain, low-roughage diets to depress milk fat content. Then sodium bentonite, an impure aluminum silicate (clay-like), was added at levels of 5 and 10 percent to the concentrate. At both levels, milk fat content returned to about 90 percent of normal. The bentonite had no adverse effect on feed intake and palatability. It may act by reducing the rate of passage of the feed.

Generally, the most economical way to increase milk fat content is simply to feed more roughage. If this is not possible, bentonite or sodium bicarbonate may have some value under special conditions. It should be remembered, however, that these products increase ration costs without adding nutrients.

Hardboard Has Good Impact Resistance

POO CHOW and WILLIAM L. REISS

In recent years hardboard has often been substituted for plywood in the construction of houses and farm buildings. The hardboard has been used for exterior siding, doors, interior lining, and underlayment for resilient flooring materials.

To produce hardboard, wood fibers are interfelted so the board has some natural bonding and the fibrous mat is then heated and bonded under pressure. Chemical additives during manufacture or oil treatments after manufacture improve the bond and strength. Hardboard is generally divided into three classes according to density: (1) medium hardboard, with a density of 31 to 50 pounds per cubic foot; (2) high density or standard hardboard, with a density greater than 50 pounds per cubic foot; and (3) oil-tempered hardboard, having a greater density than otherwise comparable standard hardboard.

Over half of the hardboard manufactured is used in building construction. More needs to be known about the characteristics of this material.

Six products compared

To supply some needed information about hardboard, a study of its impact resistance was conducted in the Department of Forestry's wood science laboratory. Impact resistance measures a material's capacity to withstand suddenly applied loads.

Tests were conducted on all three types of commercial hardboard — medium density, standard, and oil-tempered. Three species of five-ply exterior A-C grade plywood were also tested.

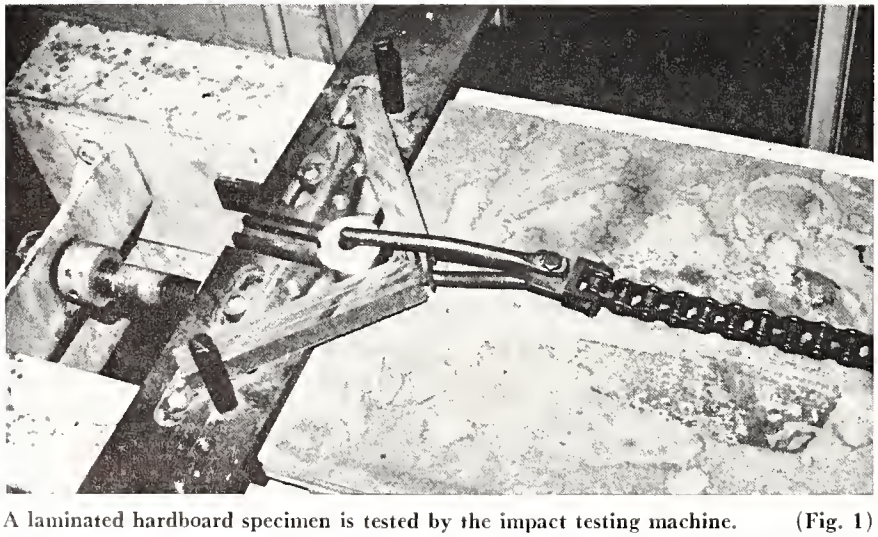
Twelve specimens of each material were cut with the grain parallel to the span and twelve were cut with the grain perpendicular to the span. This was done to determine the effect of face grain or machine direction on impact resistance.

Altogether, 144 specimens were tested. Each was 11 inches long and ¾ inch in width and depth. Hardboard thinner than ¾ inch was laminated to the ¾-inch thickness with a urea-formaldehyde adhesive. All specimens were conditioned at 70° F. and 50 percent humidity before testing. At testing time, average

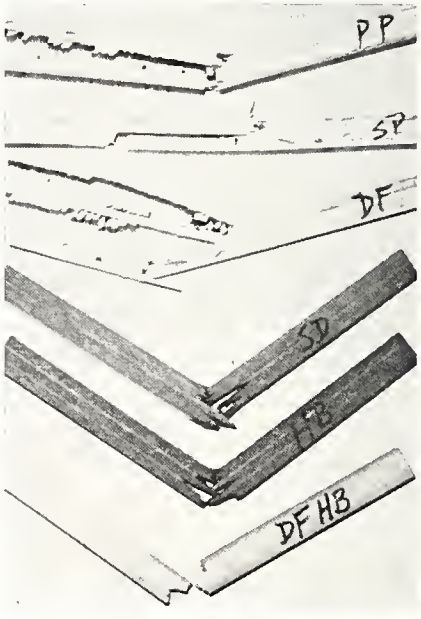
Resistance of Exterior Plywood and Hardboard to Single-Blow Impact Tests[a]

Material	Density, lb./cu. ft.[b]	Impact resistance, in.-lb.		Ratio of A to B
		Parallel to span (A)	Perpendicular to span (B)	
Ponderosa pine plywood	25	60	35	1.71
Yellow pine plywood	29	95	52	1.83
Fir plywood	31	105	70	1.50
Medium density hardboard	48	55	57	0.97
Standard hardboard	54	60	60	1.00
Tempered hardboard	59	80	79	1.01

[a] Each value is an average for 12 tests.
[b] Density based on oven-dry weight and air-dry volume.



A laminated hardboard specimen is tested by the impact testing machine. (Fig. 1)



Types of failure of plywood (top three specimens) and hardboard (lower three) in impact tests. The plywoods are: ponderosa pine (rolling shear), yellow pine (horizontal shear), and Douglas fir (rolling shear). The hardboards are: medium density siding (simple tension), tempered (simple tension), medium density (brash tension). (Fig. 2)

moisture content was 7 percent for hardboard and 9 percent for plywood.

A toughness testing machine of the type developed by the forest products laboratory was used. Each specimen was tested as a beam that had a span length of 9.5 inches and was supported by two vertical pins (Fig. 1). Force was applied to the center of the beam with a flexible steel cable that passed over a drum and had a 50-pound pendulum attached to its end. The energy from the fall of the pendulum was measured on a dial gauge and this information was used to calculate impact force in inch-pounds.

Hardboard tests well

Density of the specimens significantly affected impact resistance (see table). Oil-tempered hardboard, with the highest density, had greater resistance than any other material when the grain was perpendicular to the span; and was superior to standard hardboard, medium hardboard, and ponderosa pine plywood when grain was parallel to the span.

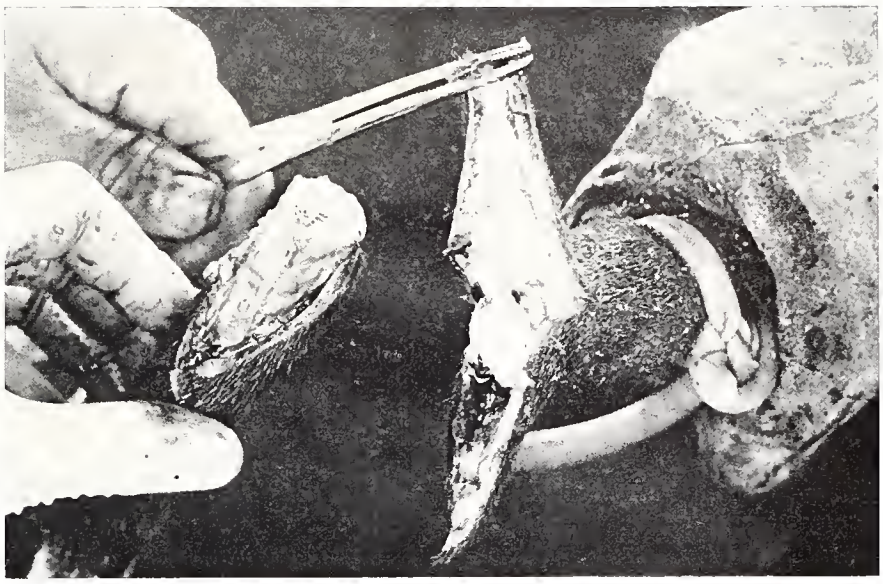
The lowest average impact values were obtained with the two pine plywoods when face grain was perpendicular to the span. All three plywoods had 50 to 80 percent greater impact resistance when grain was parallel to the span than when it was perpendicular.

Differences in impact resistance between the two face grains of the three hardboards were insignificant. Evidently the randomized fiber directions in the hardboard tend to equalize the impact resistance along the length and width of the board.

A fibrous type tension failure was typical of the hardboard specimens (Fig. 2). The rolling shear was the most common failure in plywood.

According to the results of this test, hardboard compares well with exterior grade plywood in impact resistance. Hardboard is superior in having less variability between the length and the width.

Pao Chaw is assistant professor of wood science and William L. Reiss is a graduate assistant in forestry.



A section of tail is removed below the fifth vertebra. (Fig. 1)

A Tale of a Tail

W. M. D. WILSON, E. E. HATFIELD, R. M. FORBES, and D. L. HIXON

The severed section of tail is ready for analysis. (Fig. 2)

UNLESS YOU LIKE oxtail soup, your interest in steer tails is probably minimal. However, the feedlot manager may soon find that the tail can be valuable in determining the availability of phosphorus in a steer's ration.

Now that the price of phosphorus is so high, the cattle feeder is quick to ask what minimum levels of phosphorus he must feed. He is also interested in learning how much of the phosphorus in dietary ingredients, such as corn, is actually available nutritionally when an all-concentrate diet is fed.

What is being studied

Since the skeleton contains about 80 percent of the body's phosphorus, the bones should reflect rather precisely the phosphorus status of an animal. We are therefore measuring mineralization of steers' tail bones as

W. M. D. Wilson is research assistant in animal science; E. E. Hatfield, professor of animal science; R. M. Forbes, professor of nutritional biochemistry; and D. L. Hixon, associate animal scientist.

an indication of phosphorus availability. When only the phosphorus content of the diet changes and all other nutrients are kept constant, then any change in tail bone ash weight is considered due to the level or availability of the phosphorus.

Two phosphorus sources are being investigated — monosodium phosphate (MSP) and calcium phytate (CAP). MSP is considered to be a highly available form of phosphate and thus is the standard of comparison. CAP is a commercial product which contains phosphorus in the same form as that which occurs in corn — namely, a calcium-magnesium salt of phytic acid.

In our studies supplemental phosphorus from each of the two sources is added to a high-concentrate pelleted diet containing 0.2 percent phosphorus. Three levels of CAP and two levels of MSP are being tried. The experiment includes 144 feedlot steers housed in a slotted-floor barn at the University of Illinois Beef Research Unit.

Procedure for bone biopsy

In preparation for the bone biopsy, the steer is restrained in a head gate and his tail is clipped. An area 6 to 12 inches from the tip of the tail is sterilized with alcohol. A piece of flexible rubber tubing is tied near the base of the tail to restrict the blood supply and act as a pseudo-local anaesthetic.

The bone sampled and subsequently analyzed is the fourth fully developed vertebra from the posterior of the tail (Fig. 1). Two V-shaped incisions are made, one dorsally and one ventrally, between the fourth and fifth caudal vertebrae, and the section of tail is severed (Fig. 2).

The main blood vessels are tied off with one large ligation made around the fifth vertebra with No. 1 chromic suturing material. A series of nylon thread stitches holds the remaining two flaps of skin together. The entire operation takes about 10 minutes (Fig. 3).

This operation was performed on one-third of the animals in each treatment when the experiment began. Another third were operated on after 42 days, and the remaining third after 76 days.

A second sample of tail bone was taken from all animals at the end of 112 days. At that time the seventh vertebra was used for analysis.

Interim results

Results of the experiment are shown in the table above. Treatments 2 and 5 and treatments 4 and 6 can be compared since they are calculated to supply similar levels of supplementary phosphorus but from different sources.

On the basis of these data, the phosphorus that occurs in corn as calcium phytate seems as available for tail bone mineralization as MSP under the feeding regimen used — namely, a pelleted, high-concentrate diet.

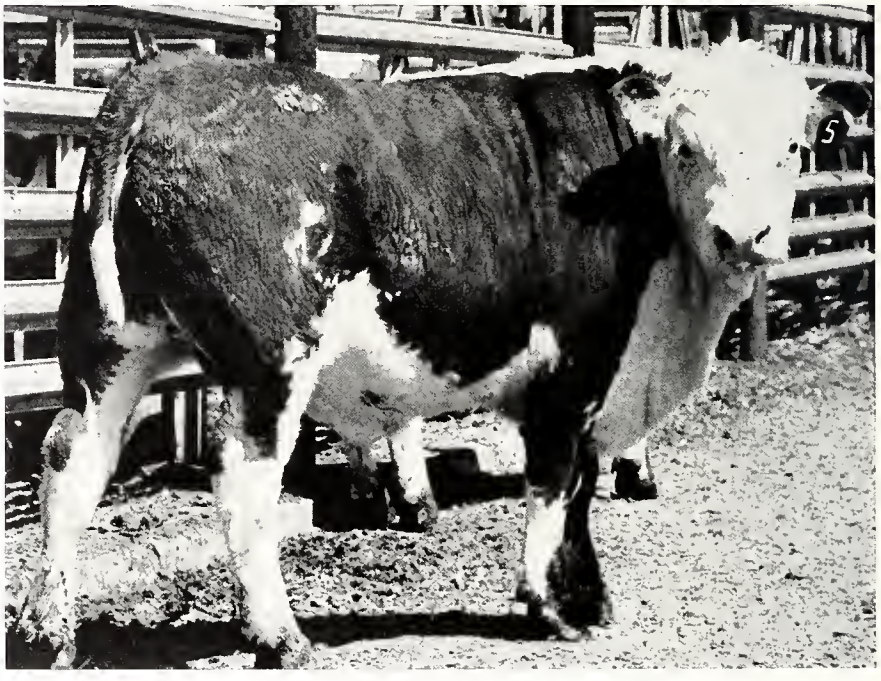
The tail biopsy offers an alternative means of precisely determining the bone mineral status of the steer at various stages throughout the growth cycle. Mean mineral values for the four time periods shown in the table indicate that the caudal vertebrae do show dramatic changes and thus offer a good sampling area.

A modification of this technique is being tried with young, undocked lambs.

Caudal Vertebro Ash Weight in Response to Phosphorus Source and Period of the Growth Cycle

Treatment	Ash weight, gm.[a]			
	Day 0	Day 42	Day 76	Day 112
1. Basal (.2% P)	.230	.336	.487	1.275
2. B+.05% P from CAP	.223	.384	.539	1.362
3. B+.10% P from CAP	.238	.383	.523	1.481
4. B+.15% P from CAP	.216	.335	.530	1.459
5. B+.05% P from MSP	.222	.339	.468	1.340
6. B+.15% P from MSP	.225	.331	.526	1.512
Mean per period	.225	.351	.512	1.405

[a]Values from the first three time periods are based upon three different random sample populations within each treatment.



None of the steers appeared to be any the worse for their operation. **(Fig. 3)**

Pick-Your-Own Sweet Corn

J. W. COURTER and G. E. McKIBBEN

PICK-YOUR-OWN has become a popular method of marketing strawberries, apples, and other fruits and vegetables. The customers drive to the farm, furnish their own containers, select and harvest the produce, and pay a fair price for the privilege. In return, they get fresh, high-quality produce and an opportunity for a family outing in the country.

In a 1969 survey of customers at pick-your-own strawberry farms in southern Illinois, many people expressed a desire to pick sweet corn, as well as other produce. At that time, no commercial growers in the area were selling sweet corn by this method. Since then, tests at the Dixon Springs Agricultural Center have provided information on advantages and disadvantages of pick-your-own sweet corn.

Growing and selling the corn

In 1971, 1972, and 1973, cultivars of different maturity were planted so that the corn would ripen in an overlapping sequence. Although the corn was sprayed for earworm control, it was not 100 percent worm-free. Selling a "baker's dozen" compensated for customer losses due to worm damage or an occasional bad ear.

The availability of the corn was advertised in local newspapers. Sales were made on University work days only. The cultivar, amount sold, and address of the customer were recorded for each sale. Later, the number of ears remaining in the field were counted and the potential harvest was calculated.

Customers liked to pick their own corn, many coming back more than once. On the average, they bought 4.5 to 6.5 dozen ears at a time (Table 1). Many purchased other produce (blueberries, blackberries, tomatoes, and peppers) and some wished that other fruits and vegetables were available.

Table 1. — Customer Harvest of Pick-Your-Own Sweet Corn

	1971	1972	1973
Aver. purchase, doz.	4.7	4.5	6.5
Customers harvesting 10 doz. or more, pct.	15	14	23
Customers buying other produce, pct.		35	45

As might be expected, yields varied with cultivar (Table 2). The amount of corn harvested depended on (1) cultivar, (2) its susceptibility to bird damage, and (3) time of maturity in relation to weekends and holidays, when sales were not made. In general, customers preferred yellow corn over white, and white over bi-color. By 1973, however, the white Silver Queen cultivar was the first choice for a number of customers who had previously sampled it.

The demand for garden vegetables was greater in 1973 than in 1972, because an extremely wet spring and widespread flooding kept many people from planting gardens. In general, customers did a good job of harvesting the available ears that year.

An occasional loss occurred because a customer would strip down an ear to check its stage of maturity and subsequent customers would pass up the stripped ear. This loss, fortunately a minor one, seems unavoidable with pick-your-own harvest. Some customers lost part of their harvest because they put ears on the ground in the field and later were unable to find them.

Some customers, especially women, were reluctant to venture 40 or more feet into the center of the fields, and picked mainly from the outer three or four rows. This problem was overcome by removing two or three rows through the center of the field to provide an open pathway.

Table 2. — Yield of Pick-Your-Own Sweet Corn

Cultivar	Date of first harvest	Yield, doz./A.	Pct. picked
1972 (Planted May 18[a])			
Royal Crest	7/19	816	100
Earlibelle	7/21	803	53
Illini Xtra Sweet	7/24	529	71
Butter & Sugar (bi-color)	7/26	540	47
Gold Cup	7/31	1,003	83
Jubilee	8/01	706	51
NCX 223	8/02	462	68
Golden Rod	8/04	808	80
Gold Crown	8/04	1,146	88
Seneca Chief	8/05	850	82
Silver Queen	8/07	625	58
Gold Cup	8/28	1,169	69
Golden Queen	9/04	514	46
1973 (Planted May 26)			
Sundance	7/22	1,026	100
Earlibelle	7/22	1,125	100
Illini Early Xtra Sweet	7/25	518	100
Gold Cup	7/28	1,600	100
Seneca Chief	7/31	684	63
Golden Queen	8/06	829	82
Silver Queen	8/06	1,214	100

[a] Exceptions were Gold Cup and Golden Queen, which were planted June 23, 1972.

Some tips for producers

Earlibelle, Gold Cup, Seneca Chief, and Silver Queen have been outstanding in production and quality, and are recommended for home or commercial planting. Other promising cultivars include Sundance, Gold Crown, and Golden Queen.

Customers will pick their own corn, but success depends on the grower's ability to advertise, schedule plantings, and attract customers during critically short harvest periods. Growers must also produce high-quality corn and provide clean, weed-free picking conditions.

A few commercial growers tried pick-your-own sweet corn successfully in 1973, and more are trying it in 1974. Pick-your-own corn and other vegetables should find a ready market as food costs continue to rise.

J. W. Courter, assaciate professar af harticulture, and G. E. McKibben, professar af agranamy, are at Dixan Springs Agriculturel Center.

Tree Size Is Clue to Past History of Woodlands

FORREST L. JOHNSON

ALTHOUGH MUCH of the forested land in Illinois was cut over before 1900, few written records of early logging operations exist today. However, a partial record lies in our forest lands and woodlots if we know how to read it. Even if a forested area appears to be in virgin condition, the distribution of tree size classes will tell us if the stand was logged in the past and, if so, when.

Why tree sizes vary

An old-growth forest most commonly has a large number of saplings, with ever decreasing numbers of trees in the larger size categories. A graph of the number of trees in each diameter category of an old-growth forest would show a curve like the dashed line in the chart.

If the forest has been logged within the past 300 years, many trees will be about the same age. This is because a large number of seedlings, which normally have a high mortality rate, will survive when the tree canopy is opened up by logging or other disturbances and the competition from larger trees is reduced.

After a few years, all the available space will again be taken up and few seedlings will survive. As these few grow, they will compete with each other for the limited resources and many will be eliminated. Only when the large group of trees in the same size class begins to die out, leaving openings in the canopy, will there be a chance for seedlings to survive in the resulting gaps.

If a graph is drawn of the numbers of trees by diameter category in the disturbed forest, the result will look like the solid lines in the graph. The peak of each curve represents the large number of trees established within a few years after logging. The right side of the curve represents trees that were too small to be cut for timber when the area was logged; the left side represents the declining reproduction due to competition from established trees.

Estimating tree ages

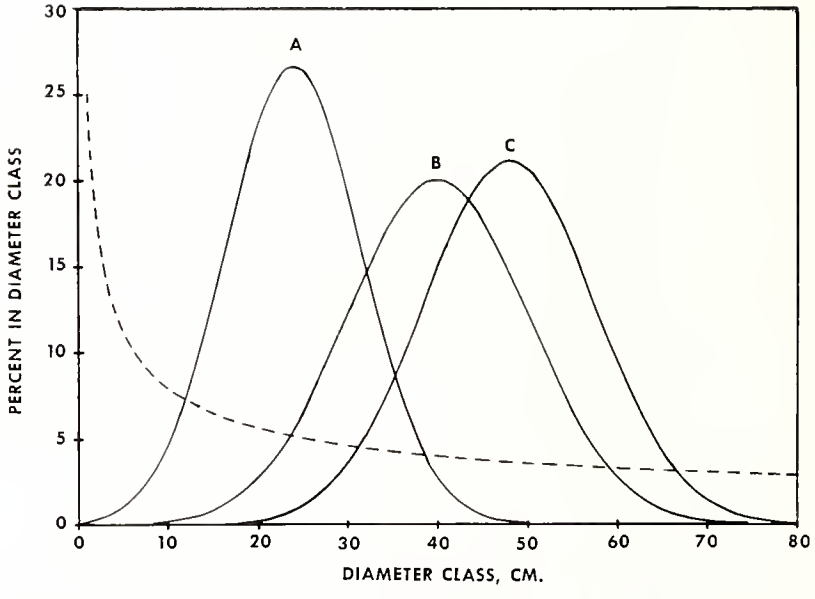
Once the diameter-class distribution of a particular species in a forested area is known, the information can be used to estimate the time lapse since logging. The diameter that occurs most frequently is divided by the average annual growth rate in diameter for that species. The result will give the approximate age of the trees that were established soon after logging.

This method was used to estimate date of logging for three central Illinois stands. One was in the Hart Memorial Forest near Mahomet; one in the Robert Allerton Park near Monticello; and one on land owned by John Oldweiler near Argenta. The diameter of every white oak (*Quercus alba*) tree within a sample area in each stand was determined. The number of trees measured in a stand ranged from 100 to 185.

The smoothed distributions of tree diameter categories for the three stands are shown as solid lines in the graph. The shape of the curves indicates that all three stands have been cut over at some time in the past.

To estimate when the logging occurred, the average diameter of the category having the greatest number of trees was divided by the average diameter growth rate (0.15 inch per year). According to the results, the Hart Forest stand was logged about 1845, the Allerton Park stand about 1855, and the Oldweiler stand about 1895. Historical data and tree-ring analysis indicate that the Allerton Park stand was logged in the early 1850's. No supporting data are available for the Hart Forest and Oldweiler stands.

The collection and analysis of tree diameter data is much less time-consuming than other methods, such as tree-ring analysis, used in estimating the age of forests. Tree diameter analysis appears to be a useful tool in studies of forest growth.



Distribution of tree diameter classes in undisturbed old-growth forest (dashed line); Oldweiler's woods (A); Allerton Park stand (B); Hart woods (C). (*10 cm. = 3.94 in.*)

Forrest L. Johnson is a forester.

Canine Heartworm Disease

KENNETH S. TODD, JR. and DANIEL L. MARK

Mosquitoes can be more than just a nuisance for your dog. Some species are intermediate hosts for *Dirofilaria immitis,* the nematode that causes canine heartworm disease.

Normally the adult parasites live in the dog's pulmonary artery and heart (Fig. 1), but occasionally they have been found in other organs. Female worms produce immature forms called microfilariae, which move throughout the dog's circulatory system (Fig. 2). The life cycle of the parasite continues after certain species of mosquitoes bite the dog and ingest the microfilariae in the blood.

In hot weather, microfilariae develop into infective larvae in the mosquitoes' circulatory systems. Many larvae then migrate to the mosquitoes' mouthparts. When the mosquitoes feed on a dog, the larvae rupture the mouthparts and enter the dog through the puncture wounds. After developing in the subcutaneous tissues and muscles, the larvae start migrating to the heart. Some of them may reach the heart about two months after the dog has been infected, but it may take four months for all the parasites to get there.

Fertilization takes place in the heart, and the females produce microfilariae. These may be found in the blood about six months after a dog has been infected.

Symptoms

Dogs respond individually to the disease. Some may show no symptoms at all, while others may die.

Symptoms are usually not evident until seven to nine months after infection. Infected animals may tire easily and be short of breath. Later, their physical condition may deteriorate, and symptoms of right heart failure and pulmonary distress may be evident. Such dogs often have a persistent cough and abnormal heart sounds. If moderately or severely affected dogs are not treated, their life span will usually be shortened. Some dogs that have few or no signs of the disease may collapse and die after vigorous exercise. Early signs of heartworm disease are often evident in hunting dogs when they are exercised for the first time before the hunting season.

Kenneth S. Todd, Jr., is associate professor of veterinary parasitology; Daniel L. Mark is a teaching associate in veterinary pathology and hygiene.

Geographical location

Heartworms are common in many of the eastern, southern, and midwestern states. For the past three years, questionnaires have been sent to members of the Illinois State Veterinary Medical Association asking about the prevalence of heartworms in Illinois. On the basis of about a 30-percent response, the disease is most prevalent in the northeastern and southern counties of the state, but it has been found in every county. Of all dogs examined for heartworms, about 10 percent have turned out to be infected.

Prevention and cure

Infections could be prevented if no mosquitoes were allowed to bite dogs, but if anyone can find a way to keep mosquitoes from biting either humans or dogs, it will be a landmark in pest control. Lacking this remedy, infections can be prevented by drugs available from a veterinarian.

Before a dog is placed on a preventive program, it must be examined by a veterinarian to assure that it is not currently infected with adult heartworms or circulating microfilariae. This examination is best performed in early April of each year.

A simple blood test will detect microfilariae; however, some dogs with adult heartworms do not have microfilariae in their blood, possibly because of immunity due to a prior infection. If microfilariae are not present, other clinical diagnostic means may be used to detect heartworms.

Adult worms in the heart. (Fig. 1)

A microfilaria in the blood. (Fig. 2)

Unless a dog is severely affected with heartworms, it can usually be successfully treated by a veterinarian. Each animal must be evaluated, and if it has other diseases, these may need to be cured before the dog can be treated for heartworms.

Adult heartworms can be removed by injecting a compound into the blood. During the first few days after treatment, the worms in the heart die and move to the lungs in the pulmonary circulation. The dead worms become lodged in the blood vessels and must be absorbed by the dog. It is essential that the dog not get any exercise for at least four weeks after treatment, while the dead worms are being absorbed.

About six weeks after treatment to kill the adult worms, the dog can be treated with another compound to remove the circulating microfilariae. The microfilariae must be destroyed to permit future preventive treatment, to prevent damage to the kidneys, and to minimize the spread of the infection via mosquitoes.

FARM BUSINESS TRENDS

Farm income increased spectacularly during the past two years, especially in 1973. Farmers' net income rose from around $13 billion in 1971 to over $32 billion in 1973, according to recent estimates of the U.S. Department of Agriculture.

Illinois farm income increased even more rapidly than the national total. The principal reason was large increases in the returns from soybeans and corn. Illinois ranks first in the sales of both of these leading cash crops.

Many unusual developments combined to raise farm prices and income. These included shortfalls in the world production of major food and feed crops in 1972, cyclical decreases in the output of animal products in the United States, and exceptional increases in the demand for food and other farm products.

The most publicized shortage was that of wheat, caused primarily by poor crops in Russia and Australia. World rice output also fell off as a result of unfavorable weather in India and southeastern Asia. The corn crop, too, was short because of restricted acreage in the United States and the drouth in southeastern Asia, Africa, and South America. The dry weather also restricted the production of peanuts, a major competitor of soybeans. Finally, the production of fishmeal, the leading competitor of soybean meal, was sharply reduced.

Here in the United States pork output was in the decreasing phase of its cycle in 1972 and 1973. Beef production also shrank cyclically in 1973, as did the production of eggs and chickens. Milk output also declined.

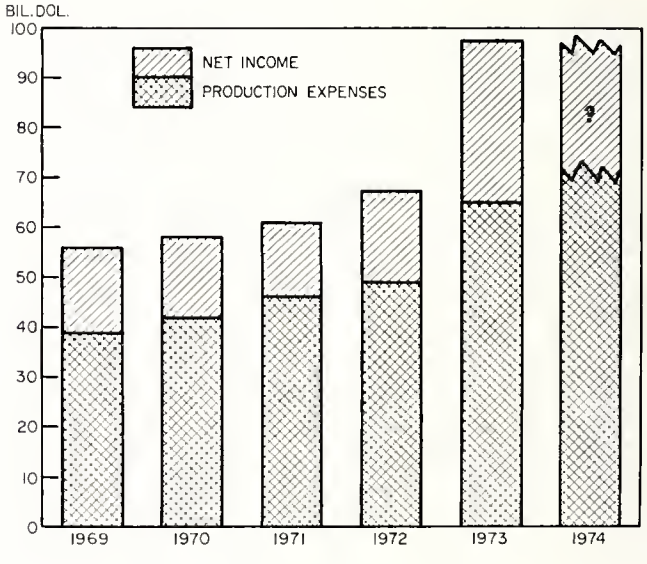
On the demand side there were larger-than-usual increases in the number of persons at work and in average wage rates. Beyond that, two devaluations of the U.S. dollar also worked to raise the prices of many farm products, especially those moving in international trade.

Another major contribution to the increase in farm income was the redemption and sale of large amounts of crops that had been produced in previous years.

Many of those price- and income-boosting factors were temporary. Then, too, rapidly increasing costs of fuel, fertilizer, machinery, and other production necessities will take more of the farmers' dollars, leaving fewer to be counted as net income. Hence net farm income seems likely to decrease substantially this year — and probably in 1975. USDA economists expect farm income in 1974 to total between $24 billion and $26 billion.

While farmers' incomes are expected to decrease substantially, there will be little or no reduction in the cost of food to consumers. Prices of a few items may decline considerably, but others probably will be marked up as a result of short supplies or increasing costs of processing and distribution.

While farm income seems likely to decrease for a year or so, there will surely be other good years for the farmers who produce our food. — *L. H. Simerl, Professor of Agricultural Economics*



U.S. farm income, 1969-1973.

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IN THIS ISSU

Rural development in Illinois

Maintaining the vitality the small town is one aim rural development progra

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 16, Number 4

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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RURAL DEVELOPMENT — WHAT IS IT?

THIS ISSUE OF ILLINOIS RESEARCH is devoted to reports from research in the Illinois Agricultural Experiment Station relating to rural development. While the diversity of topics discussed indicates the breadth of concerns in rural development, the reader should not conclude that rural development is confined only to these topics or that they represent the totality of our research efforts.

Rural development in our country is basically a policy objective aimed at creating job opportunities, community services, a better quality of living, and an improved social and physical environment in rural areas. Although "rural" is defined differently for various federal aid programs, for all practical purposes we can include as rural everyone who lives in towns of less than 50,000 (outside metropolitan areas), as well as in the open country.

Rural development is a complex process with a strong emphasis on local citizen involvement in problem identification, goal selection, study of alternatives, organization, and action. The major focus of rural development research and education is, therefore, on how rural people, individually or collectively as communities, can better take advantage of and improve the economic, physical, and social opportunities and resources in their area.

Essentially two basic kinds of research are valuable for development programs: (1) research on the development process itself to help leaders and workers do a more effective job, and (2) research which supplies the basic data needed to identify the major problems, outline possible alternatives and solutions, and determine what resources are necessary and available for solving the problems. In general, research in rural development is more "human" and "social" than the traditional technical and commodity-oriented research questions handled by Land Grant institutions.

The increasing responsibilities of the Cooperative Extension Service in rural development call for a research base comparable to that established for technical agriculture. The challenge and the opportunity for the state agricultural experiment stations is to provide research findings that will assist rural people, their organizations, and their institutions in development efforts. — *H. J. Schweitzer, Assistant Director, Agricultural Experiment Station*

Rural Development in Illinois . . .

. . . *cooperative efforts to solve complex problems*

O. G. BENTLEY

THERE IS an uneasiness in America as urbanization and other problems seem to threaten the cherished values that we associate with rural living. For among most Americans is a feeling that we all have a stake in the rural areas of our country — that they should be preserved for the benefit of rural and city dweller alike.

The unique problems of rural areas have been of concern to national and local officials, as well as to private citizens, for many years. In the 1950's special national attention was focused on the depressed farm economy, rural out-migration, and the shortcomings of supply-control programs. At that time the phrase "rural development" was coined to describe efforts to revitalize rural America.

Economic roots

Inextricably linked with rural problems are economic ones. Volumes have been written on the subject, but the salient points have been well summarized by Professor Earl Heady of Iowa State University in a publication of the North Central Center for Rural Development.

He notes that, because of rapid advances in agricultural technology, the productivity of the farm worker increased 237 percent between 1947 and 1970, as compared with an estimated 64 percent for all nonfarm workers. The boom in farm productivity has added greatly to national economic growth as workers have been freed from agricultural production to produce other goods and services.

Heady points out that "the growth in labor productivity, along with favorable prices of machine capital relative to labor, not only has directly reduced the farm work force but also has done so indirectly as it brought about pressure for larger and fewer farms." Between 1950 and 1970 the farm labor force declined from 10 million to 4.5 million.

"Since employment alternatives have been absent in many rural communities," says Heady, "persons replaced from agriculture have migrated to other locations with growing industry and employment opportunities. With this exodus of farm workers and families, rural towns and businesses have been faced with a declining demand for the goods and services they supply. . . . Consequently, rural communities that are primarily dependent on agriculture have been losing population at a rate paralleling the decline in the farm labor force."

Presidential commissions

Concern about rural problems has led to the appointment of two presidential study commissions. The first, established by President Johnson, was called the President's National Advisory Commission on Rural Poverty. Its report, "The People Left Behind," focuses attention on the inequities of economic opportunities for rural people and the lack of amenities in nonmetropolitan areas.

While the report is now seven years old and many improvements have been made, certainly some of the problems it describes still exist. At the time of the report, there were 14 million poor. The unemployment rate in rural areas averaged 14 percent compared with the national rate of 4 percent. One out of 13 houses in rural areas was classified as unfit to live in. Educational opportunities for the rural poor were limited. Health care was also inadequate, accounting for a high incidence of disease and premature death.

The second commission, appointed by President Nixon, was known as the Presidential Task Force on Rural Development. Its report, "A New Life for the Country," was issued in 1970. In addition to reviewing many of the same areas discussed in the earlier report, this task force made a case for rural development efforts in terms of broader national concerns: "The great threat that now faces us is that the social and economic ills of the nation's inner city may worsen and spread over rural areas, thus infecting the entire national structure unless we act together . . . to prevent it."

Professor Schweitzer's views

One of my colleagues, Professor Harvey J. Schweitzer, has studied the needs of rural areas and farm communities for a long time. He believes that, for many urbanizing states such as Illinois, the major rural problems are going to be those relating to urban or at least nonfarm developments. Demand is rapidly growing for mineral resources, recreation and open space, power plant and cooling lake sites, airports, highways, flood control structures, dispersion of industry around urban areas, and new residential developments. Even remote rural communities feel the impact of rising land prices generated by competition for available land as well as by higher agricultural prices.

The increase of small residential acreages in traditionally agricultural areas is becoming a major problem in many states. Unfortunately, as city people flee to rural areas for the "quality" life, they may add to the deterioration of this quality unless

O. G. Bentley is dean of the College of Agriculture.

careful planning is done. The opening of many rural areas to tourists and the recreation industry has both negative and positive aspects. Thus planning, control, and regulation become more and more important. This in turn creates serious questions about citizen involvement, who should plan and control, individuals' property rights, and the social responsibility of industry and business.

The problems of rural development in Illinois differ somewhat from those in other nearby states because Illinois has relatively few areas that are severely depressed economically. According to Professor Schweitzer, these are our major concerns:

- The ability of local governmental units to meet the needs of their constituencies.
- The need to increase nonfarm employment opportunities in rural areas.
- Continued development of agriculture as a basic rural industry.
- Provision of human and community services.
- Development of a vigorous, well-informed, and dedicated rural leadership.

Local leaders and organizations

The problems of rural America are being approached from various directions by many civic leaders and local organizations, as well as by educational institutions and governments at all levels.

Last November, I attended the State Rural Development Conference, which stressed the contributions of local leaders and organizations to rural development. The topics discussed there give some idea of the scope of rural development programs in Illinois:

- The Salem Story.
- The Crawford County Story.
- The Story of M.A.T. Industries, Inc.
- LaHarpe Cattle Grazing Association — an Example in Rural Development.
- Financing Development in a Rural Area.
- Electric Cooperatives' Role in Rural Development.
- What Are We Doing in Land-Use Planning?
- The Role of Public Agencies in Providing Outdoor Recreation.
- Recreation and Tourism as an Investment by Private Business.

The speakers were local leaders who were actively involved in development projects. I was deeply impressed by the initiative and innovativeness of these people who had been caught up in the enthusiasm of building better communities.

Educational institutions

The research capabilities of the University of Illinois can make an especially important contribution to rural development. I will briefly describe just two of the research projects in the College of Agriculture.

One project grew out of the fact that a small, but persistent, percentage of farmers in western and southern Illinois were falling behind economically. Two pilot studies identified the characteristics that were contributing to these families' plight, then established that financial planning and record-keeping was one of the major areas in which we could help them. We have also acted as a referral agent for any of these people who need access to public services.

In another project, agricultural economists and rural sociologists have been studying the effects of rapid industrialization on a rural community. The opportunity for this long-term study arose in 1965, when the Jones-Laughlin Steel Corporation announced plans for developing a major production complex in the Hennepin area of Putnam County. The first phase of the study produced baseline data on the area's economic, ecological, demographic, governmental, and educational systems before the impact of industrialization. Our researchers will monitor changes in all of these systems over the next decade or more, and may develop guidelines for predicting the effects of industrialization in other rural areas.

Government programs

In discussing formal government programs, I will limit myself to the Rural Development Act of 1972. This Act was passed with much authorization, but with only limited appropriations to carry out its provisions.

Title V of the Act authorized an expanded program of research and education directed at the special needs of rural areas. In keeping with the provisions of the Act, responsibility for the program in Illinois came to our University. Steps have been taken to implement an experimental program to last three years. With the advice of a State Rural Advisory Council, required in Title V, it was decided to stress rural leadership development in a ten-county area in western Illinois. Also in keeping with the provisions of the Act, the University of Illinois is involving Western Illinois University and local community colleges in the program.

Research and extension programs are being developed in two major areas. First, we will have programs designed to increase community leaders' skills in organization development and human relations. Second, we will have programs for developing and disseminating information on such isues as (1) natural resource use, control, and development; (2) community environmental improvement; (3) industrial development; (4) recreation and tourism; (5) local government organization and delivery of services; and (6) public finance and expenditure. Considerable emphasis will be given to helping community leaders, county boards, and local government officials "put it all together" for their own communities.

Let us hope that, with careful planning and implementation of these and other programs, we can improve the quality of rural life without destroying the charm and diversity of our great American countryside.

Off-Farm Jobs Boost Farm Family Income

R. G. F. SPITZE and R. J. HANSON

RURAL DEVELOPMENT can be viewed as a search for better ways to utilize the human, land, and capital resources of the vast countryside connecting our cities. One expanding answer to that search is dual employment, or the use of family workers both on and off the farm. Dual employment provides a productive outlet for excess farm family labor, strengthens the economy, avoids further congestion of farm migrants in the city, and enhances the welfare of farm families and of society.

We recently completed a study of dual employment among Illinois farm families — the first study of its kind in a commercial agricultural state. The research was designed to identify the off-farm income flowing to farm families, determine conditions relating to this dual employment, and assess the implications for rural development programs.

The scope, methods, and preliminary findings of this study were sketched in earlier issues of ILLINOIS RESEARCH (Vol. 14, Nos. 3 and 4). The study was based on 1971 data for 1,400 farm families with farms representative of all Illinois farms.

Growth of dual employment

According to the Censuses, off-farm employment rose from 33 percent of all Illinois farmers in 1949 to 52 percent in 1969. This rise occurred during the very period that farming was becoming more specialized, commercialized, and capitalized.

In our study, we found that 45 percent of the sample farmers and 29 percent of the wives were working off the farms in 1971. About 40 percent of the families reported that their net farm income was below $5,000 but, through off-farm employment, they attained total family incomes averaging well above $10,000. Another 20 percent, however, remained near the poverty level with a family income of less than $5,000.

Supplementing low farm income

Families with small farming operations (farm sales below $10,000) averaged less than $1,500 income from farming. However, as shown in Table 1, they added another $7,900 from off the farm. (These averages are for all farm families with small farming operations, whether they worked off the farm or not.)

Occupations and average earnings of those with off-farm work are given in Table 2. These families seemed to view their dual employment as a satisfying, permanent way of life. They gave a variety of reasons for their off-farm work, but showed little desire to leave farming (Table 3).

Meaning for rural development

A fourth of the farm families with gross farm sales below $10,000 had farms larger than 150 acres. *Specialized farm managerial and credit assistance* could help some of these families employ their farm resources more productively.

Half of both the farmers and the wives in the group had not completed high school, and 80 percent of the farmers reported no vocational training. *Job training* could benefit many of these farm families.

A third of the husbands and wives did not have more than a grade school education. *Adult education* could enhance their fulfillment both as citizens and as workers.

About 10 percent of the farmers wanted off-farm work but couldn't find jobs. *Employment dispersion* could help solve their problem.

Table 1. — Average Family Income on Farms With Less Than $10,000 Gross Sales, Illinois, 1971

Source of income	Amount
Wages, salary income	
By farmer	$4,780
By wife	1,160
By others in family	130
Net nonfarm business	792
Other off-farm income	1,052
Total off-farm income	7,914
Net farm income	1,450
Total farm family income	9,364

Table 2. — Off-Form Occupations and Eornings of Form Fomilies With Less Than $10,000 Gross Sales

Occupation	Aver. earnings	Pct. of workers
Formers		
Farm related salesman	$ 8,485	2
Nonagri salesman	8,020	3
Farm related business	22,045	3
Nonagri buninessman	9,105	5
Factory employee	8,490	22
Trade occupation	8,200	35
Agribusiness employee	4,585	8
Public service employee	7,880	21
Other	105	1
Wives		
Teacher	6,855	14
Office work	3,575	23
Medical employee	3,750	16
Food service	1,640	11
Factory employee	4,780	9
Retail sales	2,230	10
Businesswoman	6,510	4
Other	2,390	13

Table 3. — Reasons for Off-Farm Work Given by Farmers With Less Than $10,000 Gross Sales

Reason	Pct.
Improve farm capital base	28
Family and home expenses	32
Education for farm children	14
Retirement income	17
Change in work routine	3
Utilize excess farm labor	5
Facilitate move off the farm	1

Finally, adequate *welfare assistance* is the only appropriate response to the needs of about 15 percent of the farm families. These are the ones who receive less than $3,000 total income, usually because of old age, poor health, or other disabilities.

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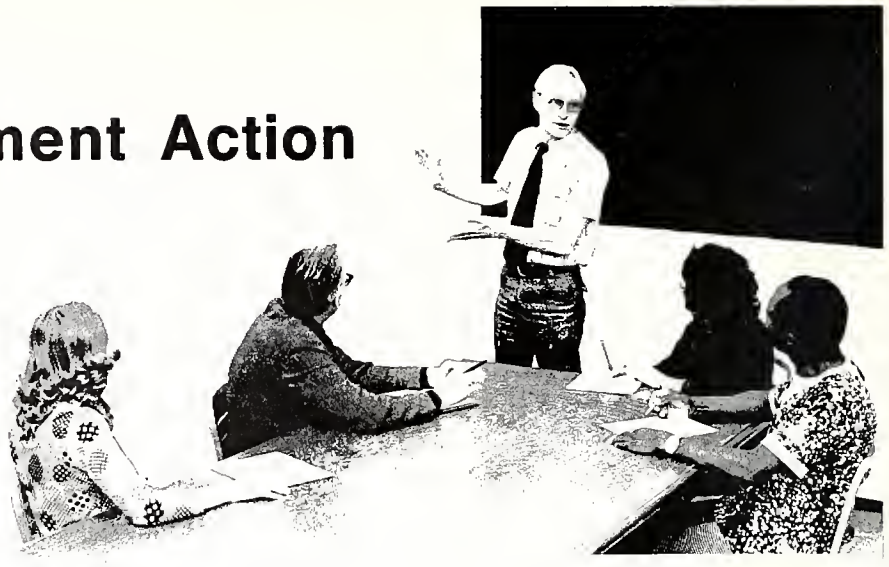
Local Government Action For Rural Development

N. G. P. KRAUSZ



PERSONAL INTERVIEWS with 336 local government officials and leaders in eight Illinois counties have pointed up the problems and possibilities of rural development programs at the local level.

The interviews were conducted in 1971-72 by the University Survey Laboratory. Objectives were to determine the kind and nature of rural development plans, analyze the factors that produce successful projects, and propose structures and procedures for action programs for rural development.

The people interviewed represented the following groups: county boards, planning and zoning boards, fire protection districts, park districts, sanitary and health districts, drainage and water districts, soil conservation districts, township supervisors, assessors and county supervisors of assessment, auditors, mayors and presidents of village boards, states attorneys, school principals and superintendents, superintendents of education, school boards, highway departments, and extension advisers.

Many part-time officials

It was heartening to find a high level of education and experience among the officials interviewed. More than a third had college degrees.

The distressing part of the findings was that 227 of the 336 government officials were serving part time and often had a short tenure. If local government is to remain viable it must come to grips with the problem not only of too many officials but also of too many on a part-time basis. As revenues, responsibilities, and sophistication of activities increase for local units, the need is for more full-time, experienced personnel.

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Degree of participation

Generally, cities and units with county-wide authority were more involved in development programs than were smaller governmental units. About half of the county, city, and special district officials in the survey were involved in some way with community development and action programs. Township officials, however, were generally not involved unless they were supervisors serving on the county board.

Most of the developmental plans that the officials reported as being in effect concerned land use, pollution control, or recreation. Other subjects mentioned included transportation, water, education, preservation of scenic beauty, and development of natural resources.

Short-term planning usual

Most planning seemed to be short-term, often to meet a particular crisis. Usually action was taken without approval from any other body. With a few exceptions, long-range planning appeared to be minimal. Planning commissions were given the opportunity of reviewing only a third of all the plans reported.

Some short-term planning cannot be avoided, particularly by small, special districts with limited objectives. But there does seem to be too little investment in long-range planning for rural development. It appears that a planning commission should be required in each county and that the commissions should have professional assistance. They should have authority to review and advise on all rural and community development proposals, and to approve or reject projects that would affect other governmental units.

In addition, planning and technical assistance from the state and from existing and proposed regional bodies should be increased. An example of continuous and direct planning assistance to counties is that offered by district highway offices.

Developing sound projects

Most local development plans became operational, which speaks well for the planning and procedures used. The officials in the survey indicated that certain procedures were important for developing and obtaining general approval of projects: (1) Select the most serious problems; (2) carefully choose a committee to review the problem; (3) hold open meetings during the planning stage; (4) use outside consultants; (5) invite other expert testimony; (6) consult with the planning commission; (7) hold public hearings; and (8) invite participation by interested individuals and organizations.

The officials generally believed that, in choosing committee members, the most important considera-

tions were to find people with experience and interest in the specific problem areas, and to obtain a broad geographic representation. Political affiliation and general civic leadership were judged to be the least important considerations. Other suggestions were that special interest groups should be heard but their use minimized while plans are being made, and that closed meetings should be avoided.

It would seem reasonable that all units be guided by these findings, subject however to the previous suggestion that plans be submitted to a county planning commission for advice or approval.

Legislative vs. executive authority

The separation between legislative and executive functions at the local government level appeared to be vague. About 40 percent of the officials said that their units enforced their own plans after adoption; 46 percent said that other units were responsible for enforcement; and 14 percent said that no one had enforcement authority. Yet most officials thought that enforcement was very satisfactory.

Despite the general satisfaction with enforcement procedures, the traditional dichotomy between legislative and executive responsibilities should be refined at the local level. The applicable laws should be studied with the objective of clarifying the responsibilities and authority of local government units, particularly planning bodies and review boards.

More cooperation needed

Cooperation between local governmental units existed in only 26 percent of all the planning efforts reported. The most usual types of cooperation were joint planning with school districts (for facilities) and with civic associations (on land use). Least involved in cooperative planning were labor unions, USDA Rural Development Advisory Councils, and some special districts and political groups.

Local officials appeared to lean strongly toward independent action. Most cooperative efforts with other governmental units were a result of mutual need, or of arm-twisting from a higher echelon, usually softened by monetary enticement. Cooperation with private groups generally was at the initiative of the group. Such cooperation was most likely when the group (or individual or business) supplied additional funds or offered expertise and experience not available to the unit.

When two or more governmental units did develop a joint program, particularly in land use and zoning, the program was usually successful, except as philosophical differences appeared between urban and rural interests. Failures were attributed to lack of funds, insufficient personnel, or poor organization.

The officials concluded that there would be much more cooperation if (1) there were better communication between units, (2) formalities for joint action were reduced or eliminated, (3) some collective action was required by law, and (4) state bureaus and regulations were reduced. Apparently, if state and regional governmental bodies want more local concerted planning and action for rural development projects, a definite plan of encouragement and funding for combined planning, as well as improved communications, will be necessary.

It would be helpful if the state could initiate a horizontal and vertical interagency communications system for each region. When rural development projects have a broad geographical impact, additional funds should be made available to coordinate planning and action procedures by all governmental units concerned. Further, some criteria should be set on a regional basis for the kinds of programs requiring cooperation between units and coordination of procedures.

Some of the cooperation problems may be solved by long-range planning, which is bound to affect more than one unit. Long-range planning should probably be required for most development projects pertaining to land use, natural resource protection, and water supply. "Partnership" agreements should be encouraged on a county, watershed, or regional basis.

Fewer units may be desirable

One barrier to local government decision-making is the large number of small units with very small budgets: over half of those surveyed had less than $50,000 a year and more than a fourth had less than $15,000.

This often resulted in focusing on paternal single-function federal and state programs. Splintered grant-in-aid programs often left rural development stranded. The larger local governmental units, such as counties, had more sources of revenue, much larger budgets, more flexibility in the selection of budget items, and less dependence on grants.

Despite the many small budgets, most officials did not express a great need for additional funds. Such funds as were needed were primarily for facilities and personnel, particularly professional planning assistance. At present only a fourth of the units have planning consultants, with an average annual expenditure of less than $1,550.

A resolve to resist any general consolidation of local units was obvious from the officials' replies. Most thought their units were operating well. However, many officials did admit inefficiencies and made suggestions to reduce costs and improve efficiency: (1) eliminate functional duplication, (2) use good business practices, (3) improve communications, (4) increase revenue, and (5) merge certain selected small units.

It would seem that the number of small governmental units with only one function should be reduced and that the remaining units should receive professional planning and management consulting assistance from counties, regional units, or cities, as appropriate. Planning commissions could be enlarged to offer this service, possibly assessing an annual charge to all units in the county that do not have their own planning sections.

Incorporated Places in Illinois

Trends between 1950 and 1970 in number, population, and geographical distribution, by size category, of towns and cities with more than 1,000 inhabitants

J. C. VAN ES

THE SMALL TOWN is still a very important part of the Illinois geographical and social landscape. But it is thriving more in the vicinity of big cities than in the rural areas of the state.

Between the 1950 and 1970 Censuses, the number of incorporated places with more than 1,000 inhabitants increased by 136, while the population of these places increased by 2.1 million. An overwhelming proportion of this growth was in metropolitan counties.

Total population increase from 1950 to 1970 was 2.4 million. This accounts for about half the total growth in the state's population between 1900 and 1970. Between 1950 and 1960, the increase was nearly 1.4 million, or 13.6 percent — the largest ever recorded in the state from one Census to the next. During the 1960-1970 decade, the increase was 1 million or 9.3 percent, representing a slight decline in both the absolute amount and the percentage of growth.

Changes in incorporated places

Table 1 shows the number of incorporated places over 1,000, according to size category, in 1950 and 1970. The increase in total number of these places was due to growth in size of incorporated places that had been under 1,000 in 1950, as well as to the incorporation of communities already having more than 1,000 population. Often both population growth and incorporation were responsible for a community moving into the general classification of incorporated places over 1,000.

Table 1. — Incorporated Places With More Than 1,000 Inhabitants, by Size, 1950 and 1970

Population category	No. of incorporated places	Pct. of all incorporated places
1950		
1,000,000 +	1	.2
100,000-999,999	1	.2
50,000-99,999	10	2.1
10,000-49,999	60	12.9
2,500-9,999	173	37.0
1,000-2,499	222	47.6
Total	467	100.0
1970		
1,000,000 +	1	.2
100,000-999,999	2	.3
50,000-99,999	18	3.0
10,000-49,999	129	21.4
2,500-9,999	219	36.3
1,000-2,499	234	38.8
Total	603	100.0

All size categories listed in Table 1 grew in numbers between 1950 and 1970 except for the largest category, which includes only Chicago. The greatest increase was in the number of towns between 10,000 and 49,999, which doubled between 1950 and 1970.

Despite the increase in the *number* of towns between 1,000 and 9,999, the *proportion* of towns in this size range declined during the 20 years. Even so, these towns still made up 75 percent of all incorporated places over 1,000 in Illinois.

In 1970 there were 234 incorporated places with 1,000 to 2,499 inhabitants. Although these towns were relatively large in number, they contained only a very modest proportion of the state's population — 3.3 percent, as compared with 30.3 percent for Chicago alone (Fig. 1).

Towns with 10,000 to 49,999 inhabitants showed the largest growth in number of people as well as the greatest increase in proportional share of the state's population. Between 1950 and 1970 the number of people in towns of this size rose from a little less than 1.2 million to more than 2.6 million. The increased proportion of the population in these medium-sized towns has been accompanied by a decline in the Chicago population.

While the number of people living in incorporated places of at least 1,000 population went up by more than 2.1 million, the proportion of the total Illinois population in these places increased only from 78.5 percent in 1950 to 81.1 percent in 1970.

Geographical distribution

Neither the distribution of population nor its changes are uniform throughout the state. It therefore becomes important to pinpoint the concentrations of population in incorporated places.

The major areas of urban concentration are obviously the larger cities and their immediate surroundings. Recognizing this fact, the U.S. Bu-

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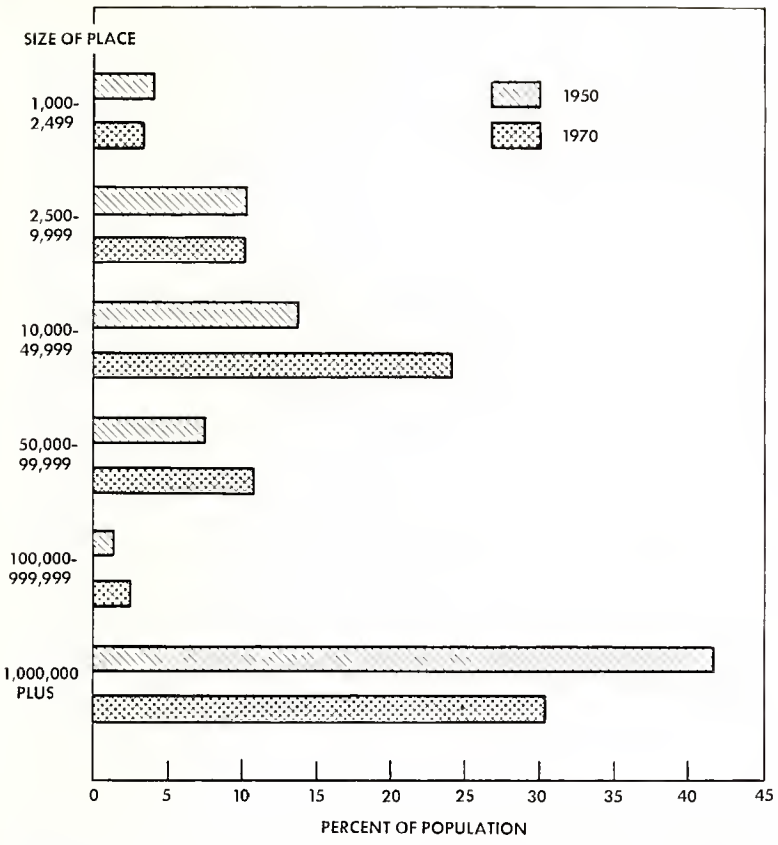
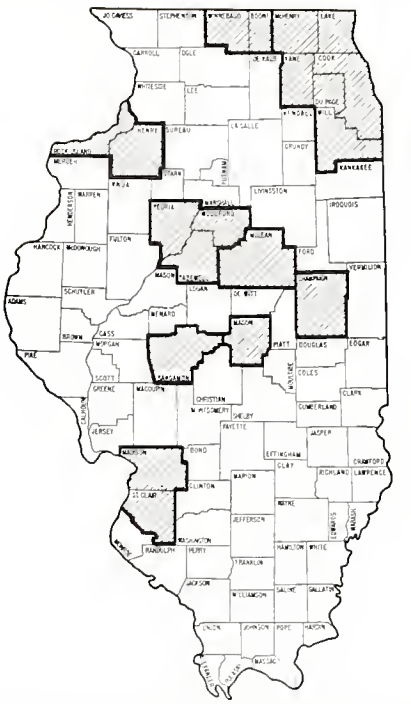


Population of incorporated places of over 1,000 inhabitants, by size, as a percent of total state population, 1950 and 1970. (Fig. 1)



Heavy lines and shading show the nine Standard Metropolitan Statistical Areas of the state, as defined in 1970 by the Bureau of the Census. (Fig. 2)

reau of the Census has designated certain areas as Standard Metropolitan Statistical Areas (SMSA's).

By 1970 Illinois had nine SMSA's (Fig. 2). Two of these — the Decatur and the Bloomington-Normal areas — had received this designation since 1950. Table 2 gives the 1950 and 1970 population for the 19 counties in the nine SMSA's and the 83 counties not in the SMSA's. These figures clearly demonstrate that the preponderance of growth during the two decades was in the SMSA counties. They gained about 1.3 million people, while the other 83 counties gained slightly less than 100,000.

Table 2. — Illinois Population in SMSA and Non-SMSA Counties, 1950 and 1970[a]

County classification	Population	Pct. of state population
1950		
SMSA	6,600,536	75.8
Non-SMSA	2,111,680	24.2
Total	8,712,216	100.0
1970		
SMSA	8,901,752	80.1
Non-SMSA	2,211,000	19.9
Total	11,112,752	100.0

[a] For 1950 and 1970 all counties are included which were parts of the SMSA's by 1970.

Table 3. — Population in Incorporated Places of More Than 1,000 by Size, SMSA and Non-SMSA Counties, 1950 and 1970[a]

Size of place	SMSA population	Non-SMSA population
1950		
50,000 +	4,662,796	...
10,000-49,999	865,267	427,891
2,500-9,999	226,152	444,456
1,000-2,499	86,287	190,047
Total	5,840,502	1,062,394
1970		
50,000 +	4,839,135	...
10,000-49,999	2,148,016	532,887
2,500-9,999	612,055	507,011
1,000-2,499	159,420	208,497
Total	7,758,626	1,248,395

[a] For 1950 and 1970 those areas are included which had obtained SMSA status by 1970.

It should be remembered, of course, that two of the rapidly growing SMSA areas in 1970 were not officially in this category in 1950, although they were counted as SMSA's in our analysis. This somewhat reduces the appearance of growth in the non-SMSA's, but not enough to have a noticeable impact on the large differences between SMSA's and non-SMSA's.

Incorporated places between 1,000 and 50,000 that are outside the SMSA's gained slightly over 200,000 inhabitants between 1950 and 1970 (Table 3). But within the SMSA's, towns of this size gained more than 1.5 million additional residents. Thus, the statewide increase in number of people living in small and medium-sized incorporated cities has occurred primarily within the Standard Metropolitan Statistical Areas rather than in the rural counties.

Retail Sales

As a Measure of Community Viability

JOHN T. SCOTT, JR., and JAMES D. JOHNSON

For a number of years, many people have been concerned about the viability of small rural communities and their potential for adjusting to a dynamic society. Numerous studies have been made of the ways in which changing farm technology affects farmers, and various farm policies have been developed to alleviate some of the growing pains. However, the effects of change on rural communities as a whole have been examined in less detail.

Changes in farm technology, as well as changes in transportation and communication, have a continuing effect on small towns. Reduced manpower needs in agriculture mean fewer employment opportunities in rural communities. Improved transportation, which lets the farmer go farther from home to do his buying and selling, has hurt many small-town businesses or caused major adjustments in operations or functions.

Besides the changes in the open country that are affecting small-town businesses, changes are also occurring in the functions normally ascribed to towns. Scale economies in retailing and service industries often seem to favor the large town over the small one. This is true not only of services offered by private enterprise, but also of such public services as education, road maintenance, and health care. The relative employment opportunities in small towns have been further reduced by the fact that most industrial development has occurred in major metropolitan areas.

Because of these evolving factors affecting small communities, we are studying retail sales as an indicator of community growth, stagnation, or decline. We have considered both aggregate sales and various categories of sales, using data from the Census of Business on Retail Trade for 1954, 1958, 1963, and 1967. (1967 is the last year for which data are available at this time. Data are collected every four to five years and there is a substantial time lag in their summarization and publication.)

Merchandise categories

Table 1 shows per capita retail sales by sales category in 1954 and 1967, together with the percent change during this period. The table does not take into account the rate of inflation. But one thing we are becoming more acutely aware of is the effect of inflation on the changes indicated by economic data. The consumer price index rose 24.2 percent from 1954 to 1967, or at an average annual rate of about 2 percent. This now seems mild, but it does mean that the "real" increase in per capita retail sales during the period was only 16.6 percent, or just over 1 percent a year.

Table 1. — Per Capita Retail Sales by Sales Category in Illinois, 1954 and 1967

Sales category	1954	1967	Change, 1954-1967
	$	$	pct.
Lumber, building, hardware, farm machinery	77	82	6.4
General merchandise	147	197	75.5
Food stores	313	426	36.1
Auto dealers	233	324	39.0
Gasoline stations	70	122	74.2
Apparel, accessories	105	131	24.7
Furniture stores	68	97	42.6
Eating, drinking places	126	165	30.9
Drug and proprietary stores	41	72	75.6
Other retail stores	112	126	12.5
Non-store retailers	94	115	22.3
Total sales	1,431	2,073	44.8

Some sales categories — general merchandise, gasoline stations, and drug and proprietary stores — gained much faster than others. Three other categories actually declined in real terms: (1) lumber, building, hardware, farm machinery; (2) "other" retail stores; and (3) non-store retailers.

The increase in general merchandise is likely due in part to a shift

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Table 2. — Number of Towns and Average Retail Sales per Town for Illinois by Town Size Categories, 1954 and 1967

Size of town by population	1954		1967		Pct. change, 1954-1967	
	No. of towns	Aver. sales ($,1000)	No. of towns	Aver. sales ($,1000)	No. of towns	Aver. sales
2,500-4,999	79	5,449	114	8,644	44	59
5,000-9,999	79	8,936	90	14,137	13	58
10,000-14,999	36	16,309	42	23,872	17	46
15,000-19,999	17	23,693	28	31,375	65	32
20,000-24,999	10	31,355	18	41,838	80	33
25,000-49,999	17	55,933	30	80,151	76	43
50,000-99,999	9	111,594	17	158,327	88	42
100,000 +	3	1,794,790	3	2,395,988	0	33

Table 3. — Retail Sales and Population, in Each Town Size Class, as Percentages of the Totals for All Illinois Towns of 2,500 or More, 1954 and 1967

Size of town by population	Pct. in 1954		Pct. in 1967	
	Sales	Population	Sales	Population
2,500-4,999	4.40	4.15	5.74	5.07
5,000-9,999	7.22	8.23	7.41	7.92
10,000-14,999	6.00	6.35	5.84	6.18
15,000-19,999	4.12	4.18	5.11	5.88
20,000-24,999	3.21	3.33	4.38	4.84
25,000-49,999	9.72	9.12	14.00	12.37
50,000-99,999	10.27	8.90	15.67	13.29
100,000 +	55.06	55.74	41.85	44.45

from other sales categories as department stores expand their merchandise range. Gasoline stations have increased both in number and in volume of sales as numbers of automobiles and trucks have risen along with number of miles traveled per vehicle. Since health care in the United States has expanded faster than most other services, it is not surprising to see a greater than average increase in retail sales by drug and proprietary stores.

Some of the merchandise sold by non-store retailers and "other" retail stores in 1954 was probably sold by general merchandise stores and drug and proprietary stores in 1967.

The "real" decline in sales of lumber, building, hardware, and farm machinery is less easily explained. A combination of things is likely involved. As farms were consolidated and increased in size, a surplus of farm buildings resulted, although some new buildings were needed to handle the services for an expanded farm operation. At the same time many contractors began buying their materials on a wholesale rather than a retail basis.

As to the sale of farm machinery, the number of units required has declined with the consolidation of farms, but the size of farm machines has increased. Total sales of farm machinery after deflation of the 1967 dollar by the price index likely remained about the same from 1954 to 1967.

Sales by town size

In Table 2, average retail sales for 1954 and 1967 are broken down according to town size. Numbers of towns in the different size categories, plus percentage changes in town numbers and retail sales, are also given.

Although the number of towns between 2,500 and 15,000 has not grown as fast as the number of larger towns, the opposite is true of growth in retail sales. In fact, sales in the small towns increased more than the state average of 44.8 percent, while in towns of 15,000 or more sales increased less than the state average.

Business Census data are not available for towns smaller than 2,500. Thus we cannot make any inferences about towns of this size. However, if we think of retail sales as one measure of community viability, we would have to conclude that Illinois towns from 5,000 to 15,000 are indeed viable and show a greater than average growth in retail sales.

One possible explanation for this phenomenon is the suburbanization process whereby people move from urban centers to contiguous or nearby small towns. In fact, a large number of the small towns of the state are in Cook County and the surrounding metropolitan counties.

As people move from the cities to the neighboring small towns, they take their demand for goods and services with them. Most of these newcomers have higher incomes than the average for the small towns into which they move, and so increase the average demand for retail goods. Thus, the average retail sales of all small towns in the state may not be a good indication of the viability of small towns in the open rural areas.

Percent of sales and population

In Table 3 we see the percentage of total state population and of total retail sales in each town size group. In 1954 the proportion of retail sales in towns ranging in size from 5,000 to 25,000 was less than the proportion of the population living in these towns. The opposite was true of towns between 2,500 and 5,000, and of towns between 25,000 and 100,000.

The same relationship existed in 1967. However, towns from 25,000 to 100,000 have significantly increased their share of retail sales relative to their population. Cities over 100,000 lost retail sales in proportion to their share of the population. This change was probably due to the suburbanization process, which left a lower per capita buying power in the cities. Finally, towns between 2,500 and 25,000 held their own in their share of retail sales.

A partial picture

As already mentioned, the average retail sales of all small towns in the state may not reflect the true situation in rural towns outside the metropolitan areas. We therefore plan to subdivide the data for small towns to remove the effects of suburbanization.

Even with a more refined analysis of retail sales, they still give only part of the picture. Other measures of community viability that need to be considered include employment in manufacturing and service industries, value added in manufacturing, and per capita income.

Tax Changes for Rural Development

H. G. HALCROW

TAX CHANGES in Illinois have shifted some of the costs for local services from local to state funds and from state to federal funds.

Between fiscal years 1966 and 1972, total state funds spent for local services shot from $1.6 billion to $4.5 billion; and federal expenditures rose from $0.4 billion to $1.5 billion. More than a third of the increase in state funding, or $1.1 billion, came from the Illinois income tax, which began in 1970. Various other revenue increases accounted for the balance.

In some communities the increase in state and federal revenues has permitted property taxes to be reduced. In other communities, property taxes either have not been raised or have been raised less than they would have been without the additional revenues.

The shift in revenue sources affects agriculture and the rural community in two major ways: It equalizes the tax burden among school districts and among different classes of taxpayers, such as farmers, wage earners, and local businessmen. Secondly, it equalizes the level of support for schooling as based on weighted average daily attendance (WADA).

Property taxes high

Even with the increased state and federal funding, schools absorb almost three-fifths of local property tax revenues. And farm property taxes remain high. In 1970, Illinois farm property owners paid one of the highest real estate tax levies in the Midwest. At $7.30 an acre, the Illinois levy was much higher than the average of the four bordering states, Indiana, Iowa, Missouri, and Wisconsin ($4.62), and was almost three times the national average.

As a percentage of full market value, Illinois property taxes are about the same as in the four bordering states and only a little higher than the U.S. average. Compared with personal income of farm proprietors, however, Illinois farm property taxes in 1970 were more than twice as high as the averages for the four bordering states and for the country as a whole.

A hypothesis examined

Would increased state and federal revenues — enough to displace all of the property tax now used for schools — result in more equitable taxation and more efficient schools? It seems reasonable to hypothesize that this would be true and that agriculture and the rural community would benefit.

To test this hypothesis, four options for completely displacing that part of the property tax used for public schools were examined: (1) increased state income tax, (2) increased state sales tax, (3) state income and state sales tax each increased one-half as much as in the first two options, or (4) a federal surtax added to the federal tax on individual and corporate income.

Each option was set to provide an estimated $1,513 million on the basis of figures available for fiscal 1971. This would allow for an average reduction of 57 percent in the property tax for the state as a whole, or 51 percent in Cook County and an average of 65 percent for the other 101 counties. The reduction would range from 56 to 74 percent in the 101 counties, and from 48 to 84 percent by school district.

Since the range by counties is from 56 to 74 percent, it was assumed that property tax reductions of 55 percent on the low side and of 75 percent on the high side would mirror the possible property tax reductions in the 101 counties if one of the four tax options had been in operation. These property-tax reductions were then applied to a sample of farm budgets drawn from Illinois farm business records. Each tax option was substituted in the budgets to determine (1) changes in income after tax in each farm size and type, (2) changes in net income per acre, (3) capitalized value of the acre income changes, and (4) the longer term effects on the farm, the rural community, and land use.

Small farms benefited

Effects on farm income of applying each of the four tax options are shown in the table. The fourth option — a federal surtax — is identified in the table as "plan A." ("Plan B" will be explained below.) In the larger majority of cases, income after tax is increased.

When income changes were calculated on an acre basis, they ranged from gains of more than 6 dollars on the smallest grain farms, to minor net losses on a few of the largest farms. If these gains were capitalized into land values, windfall gains would generally accrue to most owner-operators, particularly of small family farms.

Most tenants, unless they made new arrangements with their landlords, would lose close to a dollar an acre. Landlords, as a rule, would gain 2 to 4 dollars an acre in net rent.

Equalizing school support

Many educators believe that, on a 1971 basis, an expenditure of $1,150 per WADA is necessary for top-quality schools. Only 5 percent of Illinois school districts spend this amount. Making such an expenditure in every district would require about $1 billion additional revenue. The effects of obtaining this by an increased federal surtax is presented as "plan B" in the table.

H. G. Halcrow is professor of agricultural economics. Data are from Ill. Agr. Exp. Sta. Bul. 744, *School Tax Options Affecting Illinois Agriculture*, by Halcrow, Folke Dovring, Arthur Eith, F. J. Reiss, J. T. Scott, Jr., W. D. Seitz, and R. G. F. Spitze.

Income After Tax on Owner-Operated Farms if Property Tax for Schools Is Displaced by Increases in Other Taxes[a]

Farm size, type, and soil roting	Number of farms	Income after tax with 1971 tax structure	Income after tax if 75% or 55% of total property tax is displaced by —									
			Increased state income tax		Increased state sales tax		Combined state income and sales taxes		Federal surtax plan A		Federal surtax plan B	
			75%	55%	75%	55%	75%	55%	75%	55%	75%	55%
Grain farms, soils 100 to 76, mostly northern Illinois												
Less than 180 acres	18											
Income after tax		$ 8,594	$ 9,508	$ 9,230	$ 9,110	$ 8,823	$ 9,313	$ 9,030	$ 9,631	$ 9,348	$ 9,528	$ 9,249
Change in income			914	636	516	229	719	436	1,037	754	934	655
260 to 339 acres	69											
Income after tax		15,020	16,050	15,648	15,999	15,571	16,029	15,616	16,252	15,848	15,963	15,573
Change in income			1,030	628	979	551	1,009	596	1,232	828	943	553
500 to 659 acres	155											
Income after tax		24,070	25,094	24,534	25,081	24,482	25,099	24,520	25,220	24,671	24,495	23,979
Change in income			1,024	464	1,011	412	1,020	450	1,150	601	425	−91
800 acres and over	37											
Income after tax		36,801	37,409	36,723	37,860	37,350	37,568	37,043	36,897	36,261	35,053	34,493
Change in income			608	−79	1,059	549	759	242	96	−540	−1,748	−2,308
Grain farms, soils 55 to 5, southern Illinois												
180 to 259 acres	26											
Income after tax		9,502	9,873	9,706	9,497	9,318	9,692	9,516	10,003	9,835	9,893	9,727
Change in income			371	204	−4	−184	190	14	501	333	391	225
340 to 499 acres	79											
Income after tax		13,621	14,076	13,787	13,671	13,409	13,881	13,626	14,262	13,965	14,036	13,744
Change in income			455	166	50	−212	260	5	641	344	415	123
750 to 1,000 acres	33											
Income after tax		25,781	26,082	25,725	25,868	25,432	25,992	25,591	26,179	25,836	25,387	25,073
Change in income			301	−56	87	−349	211	−190	398	55	−394	−708
Livestock, soils 100 to 76												
Less than 180 acres (hog)	37											
Income after tax		16,753	16,957	16,738	16,764	16,540	16,812	16,645	17,163	16,942	16,840	16,628
Change in income			204	−15	11	−213	59	−108	410	189	87	−125
180 to 259 acres (hog)	52											
Income after tax		16,724	17,372	17,054	17,131	16,742	17,319	16,905	17,578	17,259	17,242	16,934
Change in income			648	330	407	18	595	181	854	535	518	210
260 to 339 acres	19											
Income after tax		17,327	18,186	17,778	18,083	17,657	18,141	17,724	18,396	17,986	18,029	17,634
Change in income			859	451	756	330	814	397	1,096	659	702	307
340 to 499 acres	18											
Income after tax		21,725	22,479	22,005	22,627	22,055	22,560	22,040	22,659	22,191	22,094	21,648
Change in income			752	280	902	330	835	315	934	466	369	−77
500 acres and over (hog)	26											
Income after tax		29,889	30,569	29,945	30,344	29,876	30,475	29,939	30,391	29,895	29,252	28,803
Change in income			680	56	445	−13	586	50	502	6	−637	−1,086
Livestock, soils 55 to 5												
180 to 259 acres (hog)	27											
Income after tax		12,390	12,629	12,453	12,175	11,990	12,410	12,229	12,800	12,621	12,617	12,443
Change in income			239	63	−215	−400	20	−161	410	231	227	53
340 to 499 acres (hog)	52											
Income after tax		16,019	16,332	16,096	15,805	15,553	16,080	15,842	16,534	16,297	16,235	16,007
Change in income			313	77	−214	−466	61	−177	515	278	216	−12
500 acres and over (hog)	44											
Income after tax		20,745	21,160	20,826	20,687	20,317	20,947	20,502	21,354	21,025	20,854	20,541
Change in income			415	81	−58	−425	202	−243	609	280	109	−204

[a] Budget data from Illinois farm business records, University of Illinois at Urbana-Champaign and Illinois Farm Business Farm Management Association cooperating.

It can be seen that under plan B gains are relatively smaller and losses larger than under plan A, although in balance farmers still gain from the displacement plus equalization. Plan B would upgrade rural schools to equality with the best school systems in the state. This would allow rural youth more mobility and also distribute the total tax burden more in line with net income.

Hypothesis seems reasonable

The general hypothesis that agriculture would benefit from the proposed tax changes seems to be confirmed by the data. If the local property tax for schools is displaced by increases in other taxes, the tax system will be more equitable and efficient and the school systems can be strengthened as recommended in responsible studies and court decisions. There can be important gains in equity and efficiency both for agriculture and for the general economy.

Prime Agricultural Land in Illinois

J. B. FEHRENBACHER, B. W. RAY, T. S. HARRIS, and E. E. VOSS

WITH CONTINUED population growth, crop production is getting increasing competition from other land uses the world over. Residential areas, factories, and shopping centers and other businesses continue to spread onto prime farmland, removing it more or less permanently from agricultural use. The time to halt this trend may not be far off if we are to meet our future food needs.

To preserve prime agricultural land for crop production, we must recognize its characteristics and pinpoint its location. At the same time we also need to identify land that is less valuable agriculturally but that can be put to other good uses. Information of this nature is essential for any sound land-use planning program for rural or urban development.

The need for more information about our land resources prompted the initiation in 1971 of a north central regional project, "Soil Landscape Characteristics Affecting Land Use Planning and Rural Development." Cooperating in the project are the agricultural experiment stations of the north central states; the Soil Conservation Service and Forest Service, U.S. Department of Agriculture; and the Cooperative Extension Service. The Illinois station has been actively participating in the project since its beginning.

The project is designed to define and map land resource areas (soil landscape units) and develop guides for recommending alternative uses for an area. To date, land resource areas for much of Illinois have been defined in terms of soil, topography, and geology. In Illinois, as in the other cooperating states, special emphasis is being placed on defining and delimiting the prime agricultural land.

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What is prime agricultural land?

Prime agricultural land means the highest quality or most productive land, but it must be defined in terms of specific crops. An area that would be prime agricultural land for vegetable or fruit crops would not necessarily be prime land for grain.

In Illinois, farmland is used primarily for the production of corn, soybeans, wheat, and oats. We have therefore defined our prime agricultural land in Illinois as that which gives the best yields of these four grain crops. In central and northern Illinois corn occupies 55 percent of the total acreage of these four crops; soybeans, 30 percent; wheat, 8 percent; and oats, 7 percent. In southern Illinois the percentages are 40 each for corn and soybeans, 20 for wheat, and practically zero for oats.

Productivity of Illinois soils for these major grain crops has been studied for many years. Average crop yields, weighted by their acreages, have been used to calculate productivity indexes for each soil under both a basic and a high level of management (Illinois Extension Circular 1016). The high level of management specifies the use of desirable practices and the inputs believed near those necessary for maximum profits.

Assuming average Illinois climatic conditions and high levels of management, the main variables affecting yield are soil characteristics and the slope of the landscape. The most important soil properties are those influencing the water and nutrient supply to plants. Increasing slope usually causes crop yields to decline because of the greater runoff (less water available) and erosion. Sloping soils are also more difficult to farm, especially with larger machinery.

Three grades of prime land

Productivity indexes for a high level of management, plus corn yields, were used to define three grades of prime agricultural land in Illinois: grade A, excellent; grade B, very good; grade C, good. Although the necessary management and energy inputs for high yields in Illinois generally increase from grade A to grade C, capital investment in land usually decreases.

The productivity indexes and corn yields for the three grades are:

	Productivity indexes	*Corn yield, bu./A.*
Grade A	140-160	126-145
Grade B	125-145	111-125
Grade C	100-130	91-110

Grade A soils are naturally fertile and highly responsive to good management. They are among the most productive soils in the world for grain crops.

This group includes moderately permeable, dark-colored soils on 0- to 5-percent slopes, which have formed under prairie vegetation in loess, medium-textured glacial till, outwash, or alluvium. Some of the soils, occurring on flat or nearly level areas, are naturally wet, but can be tile-drained satisfactorily. All soils in this group have a high to very high capacity for storing water that is available to plants. Their cation exchange capacity is also high.

Among these soils are portions of soil associations A, B, I, W, and Z as shown on the general soil map of Illinois (see Illinois Agricultural Experiment Station Bulletin 725). Extensive soils in this grade include Sable, Muscatine, Ipava, Tama, Drummer, Flanagan, Catlin, Lisbon, Elburn, Plano, Lawson, Huntsville, and others.

Grade B soils are made up of two groups. The major group includes both light- and dark-colored soils that formed in loess, till, outwash, or alluvium on 0- to 5-percent slopes.

These soils are somewhat less productive than grade A soils. The lower productivity may be due to a fine-textured subsoil, moderately slow permeability, low organic matter content, only moderate fertility, or some similar characteristic.

Drainage is needed on the nearly level areas. Ordinarily tile function adequately, although slowly, but must be spaced closer than in grade A soils.

This group makes up portions of soil associations C, D, J, L, M, N, O, W, and Z on the general soil map of Illinois. Extensive soils include Herrick, Virden, Elliott, Ashkum, Martinton, Milford, Patton, Proctor, Keomah, Stronghurst, Beaucoup, Sawmill, and others.

A second, much smaller group of soils in grade B includes soils that would be grade A (in soil associations A, B, I, and W) except that they occur on 5- to 10-percent slopes. These sloping soils usually need erosion control.

Grade C, like grade B, includes two groups of soils. The major group, which may be either light- or dark-colored, developed in loess, till, outwash, or alluvium on 0- to 5-percent slopes.

These soils have some morphological or compositional characteristic that either restricts deep root penetration to some extent or in some other way reduces the amount of stored moisture available to crop plants. Some of the soils may be slowly permeable because of fine-textured subsoils; others are somewhat drouthy because of moderately shallow depths to sandy or gravelly material.

Tile do not function adequately in the slowly permeable soils and drainage, where needed, is provided by surface furrows and ditches. Drainage is not a problem in the drouthy soils. Natural fertility is quite variable, but response to fertilization and good management is high.

This group comprises portions of soil associations E, F, G, H, K, P, T, U, V, W, X, and Z. Extensive soils include Cowden, Oconee, Cisne, Hoyleton, Swygert, Bryce, Warsaw, Camden, Blount, Beecher, Sharon, and others.

The second, smaller group consists of soils that would be grade B (soil associations C, D, J, L, M, N, O, and W) except for their 5- to 10-percent slope. Erosion is a general problem on these sloping soils.

Maps to be available

Maps showing the three grades of prime agricultural land in Illinois, based on our present information, are now being assembled. These generalized maps may not show some areas of the high-grade soils that are small or occur in a complex pattern with lower grade soils. For information on areas with complex soil patterns and for detailed soil maps, consult the standard county soil surveys published cooperatively by the Soil Conservation Service, U.S. Department of Agriculture, and the Illinois Agricultural Experiment Station.

Illinois lands not included in the three grades of prime agricultural land for grain crop production are often suitable for other crops such as hay and pasture, or for such alternative uses as woodland, wildlife habitat, and recreation.

Tax Revenues From Lands Affected by Strip Mining

HAROLD D. GUITHER

THROUGH JUNE 30, 1973, strip-mining operations had affected nearly 178,000 acres of Illinois land. In each of five counties — Fulton, Knox, Perry, St. Clair, and Williamson — affected areas totaled more than 10,000 acres.

Local government officials and citizens in counties with extensive mining have expressed concern about tax revenues from the affected land. About half of the revenue to support local government and schools in Illinois comes from real estate taxes. Reduced revenues from extensive acreages affected by mining could place greater tax burdens on other land owners.

Three counties studied

The effects of strip mining on assessed valuations and taxes paid were studied in Fulton, Knox, and Perry Counties — the three Illinois counties with the largest acreages affected by strip-mining. Altogether, 339 tracts of 160 acres each were selected at random in these counties.

Of the sample tracts, 161 had been affected by strip-mining — that is, some mining had taken place somewhere on the tract. The other 178 tracts were unaffected quarter sections in the same townships where affected tracts were located. These tracts had remained in agricultural use and were not owned by coal companies. Assessed valuations and taxes paid on the sample tracts from 1935 to 1970 are shown in Table 1.

In Fulton County, assessed values and taxes paid have generally been higher on affected land than on unaffected land since 1940. In 1970 the differences per acre in assessed valuation averaged $24.54; and in taxes paid, $0.88.

Similarly, in Perry County, assessments and taxes have been higher on affected land. In 1970, assessment per acre was $43.93 greater than on unaffected land; taxes paid, $1.67 greater.

In Knox County, on the other hand, the assessed values of affected tracts have been consistently lower than those of unaffected tracts. In 1970, affected tracts averaged $35.01 an acre less than unaffected tracts in assessed valuation; and $1.49 less in taxes paid.

Variation by type of ownership and county policy

Further study is required to determine all the reasons for the differences between the counties. However, they could be partly due to type of ownership of mined land, policies of the individual counties, and the willingness of coal companies to accept higher assessments than individuals.

Since 1940, coal companies have consistently had higher assessed valuations and paid higher taxes on affected lands than have other owners. In recent years, the spread between the taxes paid by coal companies and taxes paid by individuals has widened (Table 2).

Apparently officials in Fulton and Perry Counties have reached an informal agreement with coal companies, whereby company-owned land is assessed at the same valuation as before it was stripped — or even at a higher valuation.

In Knox County some mined tracts have been sold to individuals who could request reassessments to lower their tax bill. State law requires that real estate be assessed at 50 percent of its fair cash value. It is reasonable to expect that reclaimed spoil banks usually have less market value than productive cropland. When mined lands have been sold to individuals or only the coal rights are sold, there is strong probability that future assessed values and taxes collected from these lands will decline in comparison with unaffected agricultural land.

Table 1. — Assessments and Taxes Paid per Acre, Affected and Unaffected Land, 1935-1970

Year	Affected lands[a]		Unaffected lands	
	Assessment	Taxes paid	Assessment	Taxes paid
Fulton County				
1935...	$ 37.67	$ .95	$ 43.02	$1.03
1940...	57.19	1.52	42.78	1.18
1945...	67.13	1.89	45.19	1.36
1950...	223.24	3.92	175.21	2.25
1955...	153.11	2.31	138.86	2.85
1960...	170.39	4.17	147.84	3.82
1965...	169.46	5.07	158.48	4.78
1970...	185.26	7.15	160.72	6.27
Knox County				
1935...	39.24	.87	39.38	.85
1940...	35.75	1.04	39.62	1.20
1945...	35.54	1.22	39.20	1.36
1950...	100.87	1.66	114.57	1.89
1955...	109.04	1.38	121.54	2.63
1960...	121.58	2.72	142.30	3.24
1965...	122.97	3.34	152.05	4.26
1970...	132.31	4.43	167.32	5.92
Perry County				
1935...	28.91	.59	24.86	.57
1940...	28.26	.75	20.25	.57
1945...	29.29	.86	20.46	.64
1950...	78.32	1.32	55.19	1.09
1955...	74.68	2.27	50.31	1.37
1960...	91.99	2.76	60.87	1.88
1965...	85.08	3.13	61.75	2.23
1970...	127.82	5.51	83.89	3.84

[a] Includes only tracts where some strip mining had occurred.

Variation by land use

How strip-mined land is used after reclamation can significantly affect its assessed valuation and taxes paid per acre. This situation is illustrated by observations of six adjoining sections in Fulton County. These tracts included both strip-mined areas and farmland that had never been disturbed by mining. Some of the strip-mined land adjacent to the farmland had been reclaimed and was being

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Table 2. — Assessments and Taxes Paid per Acre on Strip-Mined Land by Type of Owner

Year	Coal companies		Other owners	
	Assessment	Taxes paid	Assessment	Taxes paid
Fulton County				
1965...	$190.87	$5.81	$157.23	$4.65
1970...	247.14	9.68	149.90	5.71
Knox County				
1965...	127.28	3.45	94.48	2.64
1970...	137.11	4.55	100.63	3.61
Perry County				
1965...	91.56	3.38	39.73	1.41
1970...	135.61	5.81	46.02	2.34

Table 3. — Assessments and Taxes Paid per Acre on Reclaimed Land Under Different Uses and on Unaffected Cropland, 1970[a]

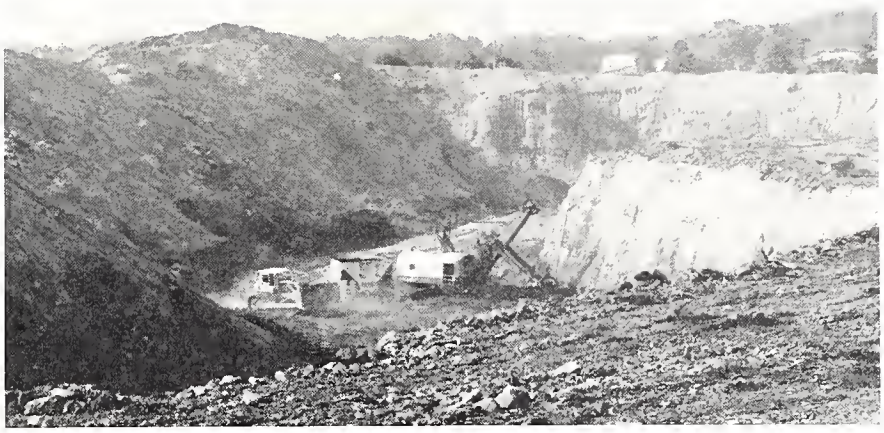
Land and use	Assessment	Taxes paid
Reclaimed land		
Pasture	$ 128.46	$ 5.05
Subdivided into residential lots	2,663.03	110.60
Improved cropland	279.62	10.79

[a] Six adjacent sections in three townships, Fulton County.

used for pastures. In the next section, reclaimed land had been subdivided into residential lots on which some houses had been built.

The improved cropland was assessed at more than twice the value of the reclaimed land in pasture. But the reclaimed land in residential lots had an assessed value and tax yields more than 20 times as great as for the reclaimed pasture land (Table 3). These figures suggest that the highest tax revenues for reclaimed spoil banks would most likely result from a productive nonagricultural use where such use is feasible and desirable.

(For a more detailed analysis, see "Illinois Lands Affected by Strip Mining," in *Illinois Agricultural Economics,* July 1974, published by the Department of Agricultural Economics, University of Illinois at Urbana-Champaign.)



More than 177,000 acres of Illinois land have been affected by strip mining. The critical issues today are how to reclaim this land for productive uses and avoid disruption of the community tax base and associated public services.

Two to three acres of reclaimed strip-mined land with well-established pasture can support a beef cow and produce a 475-pound calf each year.

This residential development on a reclaimed strip-mined area in Fulton County represents a desirable land use and a higher assessed value than the pasture land.

Women with farm, rural, and urban backgrounds are compared:

Early Background and Later Life Style

JEANNE. L. HAFSTROM, MARILYN M. DUNSING, and ALBERT W. GUSTAFSON

DOES a woman's early environment — farm, rural nonfarm, or urban — affect her later aspirations, satisfactions, and attitudes? Is this early environment related to her socioeconomic characteristics?

These questions were recently investigated with the use of data from the 1970-71 Survey of Life Styles conducted in Urbana-Champaign. Households in the survey had been selected randomly after being stratified by occupation of the head of the household.

Among other questions, we asked whether the homemaker had spent her first 18 years mostly on the farm, in rural nonfarm areas (open country or towns of less than 2,500 population), or in the urban setting. In the present study, we compared the answers to this question with numerous socioeconomic characteristics (such as age, education, occupation), and social-psychological characteristics (such as satisfactions, aspirations, attitudes).

To reduce variability, we confined the study to 488 nuclear families consisting of husbands, wives, and children. Twenty percent of the wives had spent most of their first 18 years on the farm; 19 percent, in rural nonfarm areas (hereafter referred to as rural areas), and 61 percent, in urban areas.

Socioeconomic characteristics

No significant differences were found among rural-reared, farm-reared, and urban-reared wives in characteristics of family size, ages of wife and husband, number of years married, family income, and frequency of money problems.

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Wives averaged 36.1 years of age; husbands, 38.9 years. They had been married an average of 15.5 years. Mean family size was 4.6 persons.

Mean family income before taxes was $13,796. About half of the families had incomes from $9,000 to $17,500. Ten percent had incomes below $7,000; another 10 percent received $22,500 or more.

Nearly half (47 percent) of all the wives were employed outside the home. The three groups did not vary significantly in either percentage employed or type of job held.

Fifty-eight percent of the husbands were in white collar occupations; the rest in blue collar occupations. Most of the families were white. Eighty-three percent were home owners.

Education

In the group as a whole, wives averaged 13.0 years of schooling; their husbands, 1 year more. However, the farm-, rural-, and urban-reared wives differed significantly in average educational level.

Urban-reared wives tended to have completed more years of school than the other two groups, and rural-reared wives averaged slightly more schooling than farm-reared wives (Table 1). Differences among the husbands tended to follow the same pattern as among the wives.

Education of the wives' parents also differed significantly. The fathers of 71 percent of the farm-reared wives, 48 percent of the rural-reared, and 32 percent of the urban-reared had 8 or fewer years of schooling. The mothers of 56 percent of the farm-reared wives, 37 percent of the rural-reared wives, and 25 percent of the urban-reared also fell into this category.

Table 1. — Educational Levels of Wives and Husbands

Background of wife	Highest educational level: 8 yr. or less	High school (1-4 yr.)	College (1-4 yr.)	Advanced degree
	Pct. of wives			
Farm	5	68	26	1
Rural	3	68	22	7
Urban	3	50	34	13
	Pct. of husbands			
Farm	11	49	24	16
Rural	5	56	15	24
Urban	5	34	26	35

The percentages of fathers with bachelor's or advanced degrees were 21 percent for urban-reared wives; 7 percent for rural-reared; and only 1 percent for farm-reared. Nine percent of urban-reared and 4 percent each of rural- and farm-reared wives had mothers with college degrees.

Who decides?

The wives were asked whether certain decisions were made mainly by the wife, the husband, or the two together. All three groups reported similar patterns of decision-making on: where the family lived, whether the wife worked, how to handle the children, how the money was used, who handled the money, and who was responsible for ensuring there were no more children than wanted.

The groups varied significantly on only two decision-making questions: which friends the family would see, and the number of children to have. Judging from the degree of joint decision-making on these questions, rural-reared wives were living in somewhat more equalitarian families than the other two groups (Table 2). When one spouse

Table 2. — How Two Types of Decisions Were Made

Type of decision	How decision was made		
	Jointly	Mainly husband	Mainly wife
Farm-reared wives			
		percent	
Friends to see	77	15	8
No. of children	81	10	9
Rural-reared wives			
Friends to see	85	2	13
No. of children	98	0	2
Urban-reared wives			
Friends to see	81	9	10
No. of children	89	3	8

was primarily responsible for deciding these questions, the urban- and rural-reared wives, rather than their husbands, were more likely to make the decisions. However, the opposite was true of farm-reared wives.

Satisfactions and aspirations

The three groups did not differ significantly in their satisfaction with their husbands or their levels of living. Nor did they differ as to whether they wanted their daughters to marry men who were like their husbands in occupation, ability as a provider, or personality.

When asked whether there were things they wanted for individual family members, the family as a whole, the house, or the yard, the three groups again tended to follow similar patterns. The only variable on which they differed significantly was in wanting something for the yard. Such a want was expressed by 54 percent of the urban-reared wives, but only 38 percent of the rural-reared and 47 percent of the farm-reared.

Attitudes

Some significant differences in the attitudes of the three groups were evidenced in the women's reactions to the following statements:

The best reason for getting an education is so you can be equal to others. Forty-six percent of the urban-reared wives strongly disagreed. However, only 36 percent of the rural-reared wives and 27 percent of the farm-reared wives expressed strong disagreement. The percentage who strongly agreed was about twice as high for farm-reared as for urban-reared wives, and about half again as high for the rural-reared as for the urban-reared.

Too many people on the job are just out for themselves and really don't care for anyone else. Strong agreement was expressed by 40 percent of the farm-reared wives as compared with 27 percent of the rural-reared and 22 percent of the urban-reared. The percentage of rural- and urban-reared wives who strongly disagreed was about twice that of farm-reared wives.

A good job makes a person want to take an interest in his community. Most of the wives tended to agree, but agreement was stronger among the farm-reared wives (88 percent) than among the rural-reared (76 percent) and urban-reared (73 percent). The percentage of urban-reared wives who tended to disagree was nearly 2½ times that of farm-reared wives and nearly 2 times that of the rural-reared.

Most people can expect a better job sometime. Again agreement was strongest among farm-reared wives (76 percent). Seventy-one percent of the rural-reared wives and 59 percent of the urban-reared wives also agreed. A much larger percentage of the urban-reared than of the other wives expressed uncertainty.

Pay is more important in choosing a job than what the job is. Most of the women disagreed, but disagreement was stronger among the urban-reared wives (92 percent) than among the rural-reared (85 percent) or the farm-reared (80 percent). The percentage of farm-reared women who tended to agree was nearly 3 times that of the rural-reared and 3½ times that of the urban-reared.

It is all right for women to hold jobs which are usually men's jobs. Agreement was greater among the urban-reared (66 percent) and rural-reared (61 percent) than among the farm-reared wives (42 percent). Thirty-five percent of the farm-reared wives tended to disagree, compared to 25 percent of the rural- and 20 percent of the urban-reared.

Respect for parents is the most important thing kids should learn. Most of the women agreed, but agreement was strongest among the farm-reared wives — 90 percent as compared with 84 percent of the rural-reared and 70 percent of the urban-reared. The percentage of urban-reared wives who disagreed was 1½ times that of rural-reared and 3 times that of farm-reared wives.

Some other comparisons

The three groups were similar in percentages of women born in Champaign County; in Illinois but more than 50 miles from Champaign County; and in the North Central Region (excluding Illinois). However, 17 percent of the farm-reared wives had been born outside Champaign County but within 50 miles of it, as compared with 11 percent of the rural-reared and 7 percent of the urban-reared. Conversely, 25 percent of the urban-reared wives, compared with 17 percent of the rural-reared and 11 percent of the farm-reared, had been born outside the North Central Region.

Most of the wives had relatives living close enough that they could be visited within one day. As might be expected from the preceding figures, the percentages were higher for the farm-reared (89 percent) and rural-reared (82 percent) than for the urban-reared (76 percent).

Despite these differences, the three groups did not vary significantly in being more or less likely to exchange help with relatives than with other people. Nor did they differ significantly in whether they would rather discuss problems or spend time with relatives than with others.

The three groups reported no significant differences in regular attendance at church or church organizations, or at such groups as PTA, lodge, VFW, recreation clubs, and groups connected with the job.

FARM BUSINESS TRENDS

Agriculture contributes substantially to the economic development of rural and urban areas. About 150,000 persons are employed on Illinois farms. Sales of farm products totaled $5.3 billion in 1973. Many thousands of people are employed in processing and distributing these commodities. The manufacture and delivery of farm equipment and supplies, and the provision of essential services also provides employment for many persons.

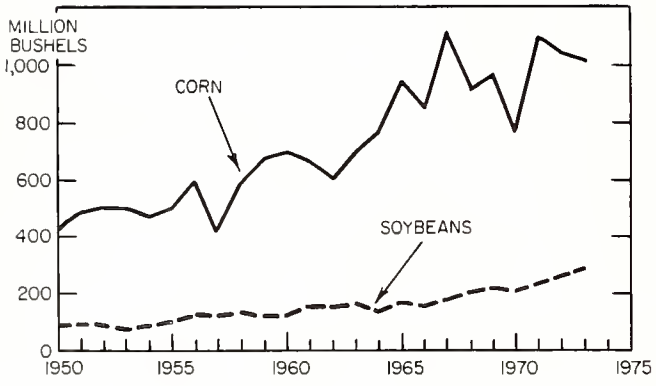
Receipts from the sale of Illinois farm products increased from $1.7 billion in 1949 to $5.3 billion in 1973. Much of that increase was due to an increasing volume of corn and soybeans and higher prices for these crops.

Corn production increased from 400 million bushels annually to 1 billion bushels. The value of the crop rose from $500 million to $2.8 billion. Soybean production climbed from 80 million bushels to nearly 300 million. Annual value rose from less than $200 million to $1.6 billion. All crop sales in 1973 totaled $3.4 billion.

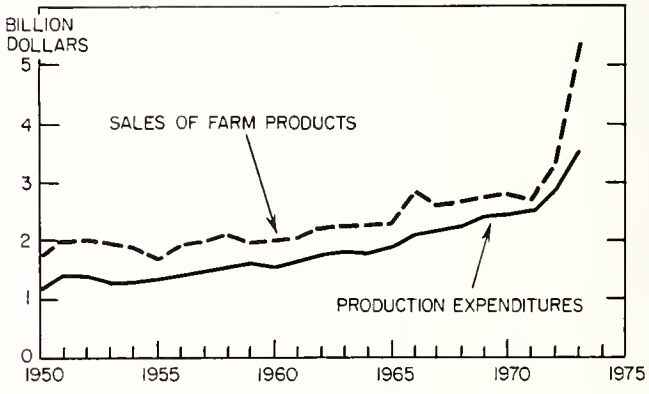
Hog production increased from 7.5 million annually to 11 million in recent years. Cash receipts from sales of hogs rose from $400 million to over $1 billion in 1973. Sales of cattle and calves from Illinois farms ranged between 1.5 million and 2.0 million. The value of sales increased from $300 million to $600 million. Total receipts from sales of animals and animal products in 1973 were $1.9 billion.

Expenditures for farm equipment, supplies, and services rose from just over $1 billion in 1949 to $3.5 billion in 1973. Outlays in 1974 probably totaled near $4 billion. Purchases of capital items, principally farm equipment and buildings, probably exceeded $600 million in 1973. Repairs and operation of capital items totaled $325 million; fertilizer and lime, $185 million; and hired labor, $130 million. Outlays for livestock were $225 million; feed, $440 million; and seed, $140 million. Rent paid to landlords was $690 million and taxes were about $300 million. Other expenses totaled about $500 million.

Many typical farm families spend $7,000 to $12,000 for family purposes. The total of such spending out of net farm income in recent years probably has been around $700 million. This outlay includes expenditures for food, housing, transportation, clothing, household equipment and furniture, medical expenses, life insurance, education and recreation. — *L. H. Simerl*



Corn and soybean production in Illinois, 1950-1973.



Illinois farm sales and production expenditures, 1950-1973.

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IN THIS ISSU

Textile durability is test with use of an Accelero (page 14).

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE Volume 17, Numbe

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CONTENTS

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Winter, 1975 Volume 17, Number 1

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FORESTRY DEPARTMENT HAS NEW HEAD

I. IRVING HOLLAND, a member of the Department of Forestry staff since 1959, was named head of the department last November. He had been acting head since 1973.

A native of Texas, Dr. Holland spent most of his early life in California. He received a B.S. degree in Forestry, an M.S. in Range Management, and a Ph.D. in Agricultural Economics from the University of California at Berkeley. From 1941 to 1957, except for three years in the U.S. Army, he held various positions with the U.S. Forest Service, first in California and later in Washington, D.C. Before he came to Illinois, he was on the staff of Iowa State University for two years.

Since joining the University of Illinois staff, Professor Holland has engaged in a wide range of activities. Besides teaching courses and conducting research in forest economics, he supervised the forestry teaching program as associate head from 1971 to 1973. In 1965-66 he was vice-chairman and in 1966-67, chairman of the Division of Forest Economics and Policy, Society of American Foresters. While on sabbatical leave in 1965-66, he served as consultant in forest economics to the Department of Forestry, FAO, Rome. More recently, he was consultant to the President's Advisory Panel on Timber and the Environment, receiving a Presidential Citation for his contributions to the panel. Since 1973 he has been co-director of the Springer-Sangamon Environmental Research Program of the University of Illinois.

Professor Holland has done extensive research on the marketing of forest products including the empirical description of the demand and supply relations for some of these commodities. He has also studied the role of forest resources in the economy of developing countries; formulated educational curricula in forestry for these countries; investigated forestry problems peculiar to the tropics; and devised methods of forecasting timber requirements for both developing and developed countries. Other research has concerned the impacts that major reservoir impoundments and other activities connected with water resource development might have on the total ecosystem.

He is co-author of a book, *Predicting the Success of Alternative Government Incentive Programs: A Case Analysis of Small Woodland Owner Behavior,* and is the author or co-author of more than 20 major journal articles, reports, and bulletins. — *G. W. Salisbury*

Tile Drainage as a Means Of Increasing Tillage Days

Is it better to invest in a drainage system that will permit more days in the field, or in new machinery that will make the work go faster?

RONALD L. ELLIOTT, WALTER D. LEMBKE, and DONNELL R. HUNT

For anybody thinking of installing an improved drainage system, a very important question is this: How many, if any, field working days will the improvements be likely to add?

More working days either will allow tillage and planting to be finished in a more timely manner or will permit the use of less expensive machines with a smaller capacity. An economic trade-off exists, then, between installing more drainage or buying high-capacity equipment to complete field operations within the fewer working days available on the poorly drained farm.

A method for estimating the number of tillage days that would be added by different degrees of drainage has recently been developed in the Department of Agricultural Engineering. So far we have tried the method on two soils in central Illinois.

Soil moisture must be estimated

Soil moisture content is the most critical factor in determining whether tillage operations are possible on any given day. *Field capacity* is the soil moisture content after a short drainage period immediately following a sizable rainfall. This drainage period is less than a day for sandy soils but is several days for silt loams or clays. *Wilting point* is the soil moisture content at which plants can no longer remove moisture from the soil.

Total available moisture is the total amount between field capacity and wilting point and is determined by the kind of soil. When moisture content drops to 80 percent of the total available moisture, tillage operations can be performed without damaging the soil.

Measuring soil moisture content in the field is not practical for long periods of time and over a wide range of locations. So to predict available days for tillage, some method of estimating the soil moisture content is required. One method is to measure rainfall, then subtract downward percolation, surface runoff, and evapotranspiration (transpiration from plants, plus evaporation from the soil surface). The remainder is the change in soil moisture. This method is referred to as a soil-water balance.

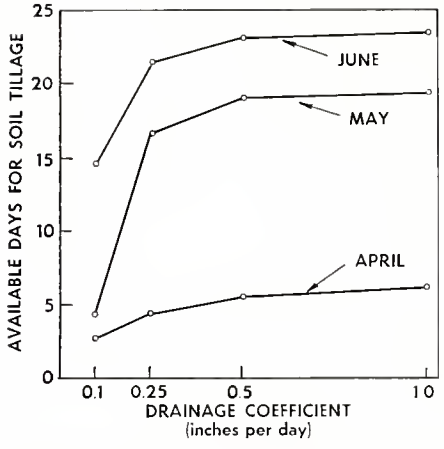
Ronald L. Elliott is an engineer with the Illinois Environmental Protection Agency. Walter D. Lembke and Donnell R. Hunt are professors of agricultural engineering. This article is based on Mr. Elliott's M.S. thesis.

Experimental model

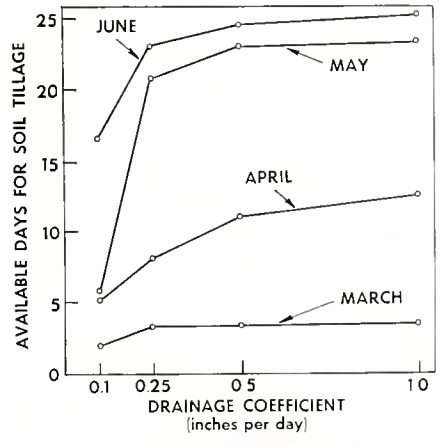
In this particular study, the soil-water balance method was used in a mathematical model of the surface three feet of soil. There were assumed to be no growing plants — the normal field condition for spring tillage. Therefore, water loss by evapotranspiration included only soil-water evaporation with no transpiration by plants.

Evaporation was estimated on the basis of average daily temperatures determined from weather records. Precipitation amounts were also obtained from weather records. The records were from central Illinois for March through June, 1964-1973.

Tile drainage from the soil entered into the soil-water balance model. Soils classified as well tiled had good gravity drainage and reached field capacity within two days after satura-



Average days available for soil tillage with various drainage conditions, Flanagan silt loam. (Fig. 1)



Average days available for soil tillage with various drainage conditions, Maumee fine sandy loam. (Fig. 2)

tion. Soils classified as poorly tiled were inadequate in both surface and subsurface drainage. These would be the "wet spots" of a field that are normally the last to be tilled and planted each spring.

Drainage coefficient

A parameter known as the drainage coefficient was used to categorize the capabilities of the total drainage system. The drainage coefficient is defined as the total inches of water that can be removed from the field per day by the combination of deep percolation and the existing tile and surface systems.

Suppose, for example, that runoff and surface drainage water from a given storm total 1 inch. If four days are required to remove the water, the drainage coefficient would be 0.25 inch per day. If the water is removed in two days, the drainage coefficient would be 0.5 inch per day. Once the drainage system has removed this excess water, the poorly drained areas of a field are considered to have reached field capacity. Soil water is then removed only by evaporation.

Since this study concerned only soil tillage in the spring, the drainage requirements for proper plant growth were not considered. It was assumed that if drainage water were removed to permit tillage operations, the water table would be far enough below the soil surface for efficient crop production. Drainage water in this study was taken to be all water in excess of that stored in the upper three feet of the soil profile.

Model tested and applied

The water balance model was programmed for the computer, and daily values of the model variables were printed as output. A "yes" or "no" was also printed indicating whether or not tillage was possible on that day.

The computer model was tested against data of the Illinois Cooperative Crop Reporting Service and against daily field observations during 1972. It was found to be sufficiently accurate for predicting available days for soil tillage over a month's time.

The model was applied to Flanagan silt loam and Maumee fine sandy loam soils in central Illinois. Results were obtained for five different drainage conditions ranging from well-tiled soil to poorly tiled soil. Average days available for tillage per month were determined for each drainage condition. The trends for the two soils are shown in Figures 1 and 2.

As the drainage system was improved from a drainage coefficient of 0.1 inch per day to one of 0.5 inch, the number of available tillage days greatly increased — especially in May. Increasing the drainage coefficient from 0.5 to 1.0 inch would give very little additional time in the field (Figs. 1 and 2). In virtually all cases, there was no increase in available tillage days as drainage coefficients were raised above 1.0 inch.

As can be seen in the figures, soil type had a marked effect on the number of field working days. For example, with a drainage coefficient of 0.5 inch, Maumee sandy loam had an average of 22 days available for tillage in May, while Flanagan silt loam had only 18 days.

Points to consider

The results from the model can be used in comparing the cost of larger tillage machinery with the cost of better drainage. A drainage system investment to increase the drainage coefficient beyond 0.5 inch per day would probably have questionable value when compared with other investment opportunities such as larger and more reliable machinery.

With lower drainage coefficients, investment in drainage becomes more attractive. Assume, for example, that a farm has an inadequate drainage system on Flanagan silt loam. The present drainage coefficient is only 0.1 inch per day. According to Figure 1, only four days are available for tillage, on the average, during May. An investment in drainage could be made to bring the drainage coefficient up to 0.5 inch per day, thereby increasing the available tillage days to 18. On the other hand, very high-capacity machinery might be purchased to accomplish the tillage operation in four days.

In making his choice of investments, a farmer must consider other factors besides available tillage days. For example, he should consider the available labor for operating and repairing his present machinery during the additional time bought by better drainage. Even with more tillage days, if the machinery breaks down the crop won't get planted at the proper time. Also to be considered are the benefits of a drainage system in addition to the number of tillage days. Of particular importance are the benefits of increasing soil aeration and temperature to provide a better environment for plant growth.

Viruses That Attack Fungi

PAUL D. SHAW

IT HAS BEEN KNOWN for many years that viruses can infect plants, animals, and bacteria, and that they cause human diseases as diverse as the common cold, measles, and possibly even certain types of cancer.

As early as 1936 there were suggestions that viruses might also infect fungi. However, biologists continued to consider fungi as the one major group of living things in which virus diseases had not been demonstrated. Then, in 1962, British scientists discovered viruses in diseased mushrooms from commercial mushroom beds. In 1967 viruses were found in other fungi, and since then they have been detected in over 60 different fungal species.

Fungi play many roles in our lives. For example, *Saccharomyces cerevisiae,* the common yeast, is a fungus used in the baking and fermentation industries. Fungi are used in the production of antibiotics and other drugs, in cheese making, and in the manufacture of many other useful products. In addition to these useful functions, fungi are among the major causes of plant diseases and also cause many diseases in animals. It is therefore very important that we understand how viruses may affect the activities of fungi, whether these activities are beneficial or destructive.

Detection difficult

Fungal viruses are difficult to find because they usually do not cause obvious "disease" symptoms in the host fungi. There are some exceptions, however, such as the mushroom viruses that cause stunted mushroom caps, distorted stems, and a generally reduced yield. Other viruses kill some fungi by destroying the membranes that surround fungal cells so that the contents of the cells leak out. Sometimes viruses may cause a phenomenon called sectoring. This is the appearance of pie-shaped areas in circular fungal colonies (such as might be seen in common bread mold). Viruses may also reduce the growth rate of a fungus.

Production of metabolites

Many fungi produce compounds called secondary metabolites. These include antibiotics, such as penicillin, and toxins, such as the aflatoxins. There are some indications that virus infections in fungi might be related to the production of these compounds. For example, strains of *Penicillium chrysogenum* that are used in the commercial production of penicillin are virus-infected, and the production of a toxin by *Helminthosporium victoriae* may be correlated with the presence of a virus. A toxin-producing strain of *Penicillium atrovenetum* that we have been studying contains particles that might be viruses.

Certain strains of yeast and *Ustilago maydis* (corn smut organism) are called "killer strains." They appear to contain viruses which cause the production of toxins capable of killing other strains of the same organism, but which, at the same time, protect the toxin-producing strains from their own toxins.

In other cases, the production of secondary metabolites is associated with the absence of viruses. For example, strains of *Penicillium stoloniferum* and *Penicillium brevicompactum* that produce the antiviral antibiotic, mycophenolic acid, do not seem to contain viruses, while strains that do not produce the antibiotic are virus-infected. Similarly, strains of *Aspergillus flavus* and *Aspergillus parasiticus* that produce aflatoxins are free of viruses but strains that do not produce aflatoxins do contain viruses.

Fungal viruses and plant diseases

Viruses have been found in at least ten species of plant-pathogenic fungi. Two of these — *Helminthosporium victoriae* and *Ustilago maydis* — have already been mentioned. Other important pathogens are *Helminthosporium maydis* (southern corn leaf blight) and *Puccinia graminis* (wheat rust).

The role of viruses in pathogenicity is not clear, but it has been found that virus-infected isolates of *Ophiobolus graminis* (root rot of wheat) are less pathogenic than virus-free isolates. It has also been suggested that the presence of viruses in *Endothia parasitica* (chestnut canker) and *Helminthosporium victoriae* (Victoria blight of oats) might decrease the pathogenicity of these fungi. The presence of a virus in *Helminthosporium maydis,* on the other hand, does not appear to affect the pathogenicity of the organism.

Questions are asked

The study of fungal viruses is very new, and we still have much to learn about them. Workers in the field are asking such questions as: How are fungal viruses transmitted? How do they reproduce? Can fungi be made to produce antibiotics by infecting them with viruses? Another question is whether fungi act as carriers of viruses that cause plant diseases. It is known, for example, that yeast can be infected with tobacco mosaic virus.

Workers are also asking whether fungal viruses can be used in the cure of disease. One successful attempt has been the treatment of chestnut canker with extracts thought to contain viruses. Another fungal virus has been found to alleviate the symptoms of influenza in mice.

It is obvious that research on fungal viruses opens up many new approaches to the understanding and possible treatment of both plant and animal diseases.

Paul D. Shaw is professor of biochemistry, Department of Plant Pathology.

Irrigation of Field Crops: Should You Try It in 1975?

M. D. THORNE, C. J. W. DRABLOS, and F. J. REISS

EVERY SECTION of Illinois normally receives more water as rain and snow during a year than it loses by evaporation from the soil and transpiration from plants. Nevertheless, there is never a year when soil moisture is not deficient for optimum crop growth sometime during the growing season.

Together, soil evaporation and plant transpiration are known as evapotranspiration. Potential evapotranspiration is the loss when conditions are most conducive to evaporation and transpiration.

In an average year, potential evapotranspiration exceeds precipitation from May to September (Fig. 1). Crops will grow during this period if one or more of the following conditions prevail: (a) stored soil moisture is sufficient to make up the deficit during the growing period; (b) actual evapotranspiration is reduced appreciably below potential evapotranspiration; (c) additional water is added by irrigation.

Crops growing on deep soil with high water-holding capacity may get by quite well if precipitation is not appreciably below normal and if the soil is filled with moisture at the beginning of the season. Fine-textured soils with a high organic-matter content have good water-holding capacity.

Evapotranspiration can be reduced by getting fast early growth to help shade the soil, by mulching, or perhaps by transpiration retardants. When soil moisture is limiting, evapotranspiration is reduced, but yields are usually reduced also.

Periods of below-normal rainfall in the summer are also usually periods of above-normal temperatures and soil moisture may become severely limiting. Data from Iowa State University have shown as high as 40 percent reduction in yield of corn from four consecutive days of visible wilting at the time of silk emergence. Tennessee studies have indicated nearly 30 percent decrease in soybean yields from moisture deficiencies during flowering and pod-filling.

M. D. Thorne is professor of agronomy; C. J. W. Drablos, associate professor of agricultural engineering; and F. J. Reiss, professor of farm management and land economics.

Rain probability in Illinois

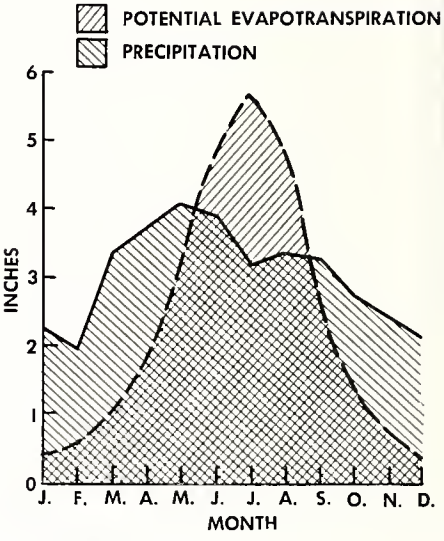
The probability of getting 1 inch or more of rain in any week in Illinois is shown in Figure 2. An inch of rain per week will not replace evapotranspiration losses during the summer but it is enough to keep moisture from severely limiting crop growth on soils with reasonably good moisture-holding capacity.

Unfortunately the probability of getting at least an inch of rain per week is lowest in all sections of Illinois during the time corn is normally pollinating — the last half of July. Irrigation can prevent moisture deficiencies during this and other critical periods in crop growth.

Yield increases

A survey was made of irrigation research in the North Central states from 1950 through 1958. Irrigation, it was found, could increase annual corn yields by about 30 bushels per acre on loams and nearly 60 bushels on sands. These increases resulted from irrigation when plant population and fertilization were both high enough that the plants could utilize the added moisture.

At the Dixon Springs Agricultural Center in southern Illinois, irrigation increased annual corn yields by 14 to 47 bushels per acre from 1955 to 1965. Average annual increase was 29 bushels per acre. In Mason County, in central Illinois, irrigation boosted yields to as much as 178 bushels per acre in 1974. This was on sandy soil where early planting was possible.



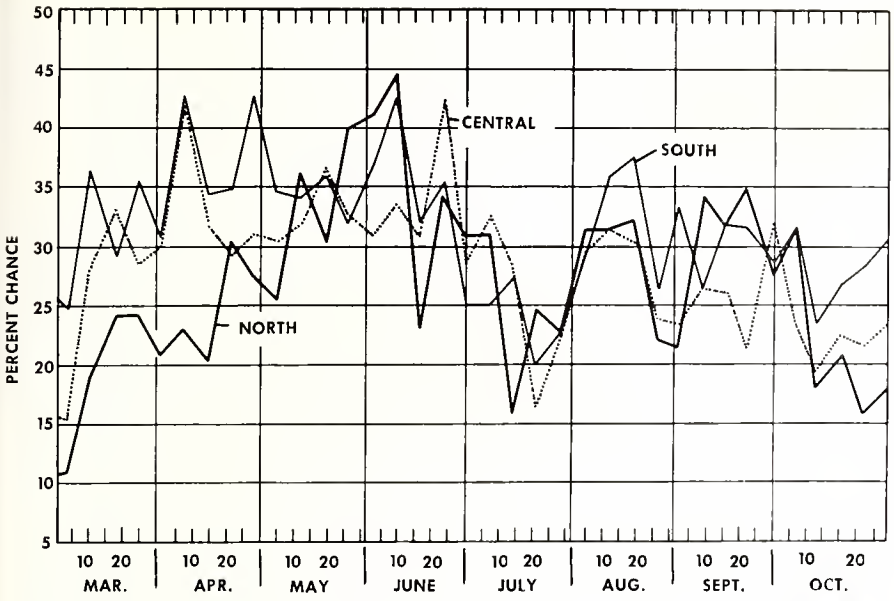
Mean annual precipitation and evapotranspiration at Urbana (from Agronomy Facts C-36, December 13, 1965). (Fig. 1)

Irrigation increased soybean yields by 10 bushels per acre in Kansas in 1971 and 1972, and by as much as 20 bushels in Texas in 1967. Louisiana reported three-year mean increases of 8 to 19 bushels per acre.

Double-cropped soybeans

Irrigation may be especially valuable for soybeans planted as a second crop following wheat. Without irrigation, moisture in July may be inadequate to get the soybeans off to a good start. As shown in Figure 2, no part of the state has much better than a 25- to 30-percent chance of getting 1 inch or more of rain per week during the month.

In 1972 G. E. McKibben and



Chance of 1 inch or more of rain in 1 week in Illinois (from Agronomy Facts M-43). (Fig. 2)

Yields of Soybeans Following Wheat, Urbana, 1972

Variety	Nonirrigated		Irrigated		Increase for irrigation			
	20″ rows	30″ rows	20″ rows	30″ rows	20″ rows		30″ rows	
	bushels per acre				bu.	pct.	bu.	pct.
Beeson	34.0	23.4	38.2	30.4	4.2	12.3	7.0	29.9
Amsoy 71	27.4	20.8	38.1	30.0	10.7	39.1	9.2	44.2
Hark	24.6	17.0	35.8	25.3	11.2	45.5	8.3	48.8

M. G. Oldham evaluated irrigation of soybeans following wheat on the Agronomy South Farm at Urbana. Soybeans were planted July 6, 1972, in wheat stubble with a zero-till planter. Irrigated plots received 3 inches of water on July 10 and another 2 inches on July 24.

Rainfall was below normal in July but above normal in August (6 inches) and September (8 inches). Relatively high yields were thus obtained from nonirrigated plots. Nevertheless, yields of Amsoy and Hark soybeans were increased by 40 percent and more in both 20- and 30-inch rows (see table).

Cost of irrigation

In 1969, annual fixed and variable irrigation costs were nearly $30 per acre in Illinois, according to two separate studies. Since then, costs of equipment, fuel, capital, and labor have all increased sharply. We do not have accurate data on current costs; however, index numbers of prices paid by farmers have been applied to the earlier cost data. The resulting estimate is that annual costs may run as high as $50 per acre in 1975. Some equipment is in short supply and long delays may be encountered in getting delivery on orders.

Whether to irrigate in 1975

Illinois Extension Circular 763, "Irrigation, Is It for You?" discusses many of the factors to consider in deciding whether to irrigate. These include the crop; the soil; water supply and cost; labor supply and cost; type of equipment, its availability, and cost; fuel availability and cost; and capital availability, cost, and alternate uses.

If we assume that an average increase of 30 bushels of corn per acre can be obtained from irrigation, the net return expectations should be better in 1975 than they were when corn sold for a dollar a bushel. Even if annual costs are as high as we estimate ($50 an acre), the value of the increased production could be nearly twice the cost.

As already pointed out, irrigation of double-crop soybeans looks especially interesting. While it may be difficult to justify an investment in irrigation for double cropping alone, the potential benefits from irrigating a second crop may be enough to tip the scales in favor of irrigation. Some growers report that, having decided to irrigate, they will give double-crop soybeans top priority in their irrigation scheduling.

Management requirements

Irrigation will provide maximum benefit only when it is an integral part of a high-level management program. Good seed of proper genetic origin planted at the proper time and at a sufficiently high plant population, accompanied by optimum fertilization, good weed control, and other recommended cultural practices, is necessary to assure maximum benefit from irrigation.

Some farmers who invest in irrigation soon become disappointed because they do not manage the irrigation properly. They often overextend their systems so much that they cannot maintain adequate soil moisture when the crop requires it.

For example, the system may be designed to apply 2 inches of water to 100 acres once a week. In 2 or more successive weeks, soil moisture may be limiting, with potential evapotranspiration equaling 2 inches per week. If the system is used on one 100-acre field one week and another field the next week, neither field may receive much benefit. This is especially true if moisture stress comes at pollination time. Inadequate pollination may result, with barren stalks competing with grain-producing plants for moisture, nutrients, and light through the rest of the season.

A high level of management of all practices, including irrigation, must be practiced for optimum returns.

Dairy Cattle Twins Aid Research

A. L. KUCK and M. GROSSMAN

As EARLY as the 1920s, research was conducted on human and cattle twins. In 1930, like-sexed cattle twins were used in studies of genetically and environmentally determined traits. This work sparked interest in further research on dairy cattle twins.

In differentiating between genetic and environmental factors, it is advantageous for animals subjected to certain environments to be genetically identical. However, this advantage depends upon accurate criteria for distinguishing identical (one-egg or monozygotic) from fraternal (two-egg or dizygotic) twins. In 1932 researchers developed some criteria based on a study of similarities and differences between twins for a large number of traits. A "similarity index" was used to score each set of twins, but no clear distinction could be made between monozygotic (MZ) and dizygotic (DZ) twins.

Since then, similarity diagnosis has improved, primarily because of work in New Zealand and Sweden. Color characteristics were found to be important in breeds such as Jersey and Ayrshire, which have a large variation in color pigmentation on different parts of the body. However, environmental influences can modify color shade and distribution. Conformation of the head and body are, to a large extent, genetically controlled; therefore, distinct differences will indicate that twins are dizygotic.

Unfortunately, most morphological traits are indistinct in new-born calves. This creates a problem, because it is often desirable to place animals in their respective experimental groups at an early age. Using morphological traits as the only basis for distinguishing between MZ and DZ twins, one would expect at least 6 to 8 percent error. With the additional aid of blood typing and other serological tests, however, it is now possible to reduce the error to about 1 percent.

A. L. Kuck, a graduate research assistant, and M. Grassman, assaciate prafessar af genetics, are bath in the Department af Dairy Science.

Advantages and disadvantages

The use of genetically identical twins has obvious advantages, not only in studies of heredity vs. environment, but also in comparisons of different treatments.

When two or more treatments are being compared, it is essential that all causes of variation, other than those being investigated, be kept to a minimum. As is well known, the phenotypic expression of an animal's producing ability has two major causes: the genotype of the individual and the environment in which the genotype is acting. With MZ twins, which have identical genotypes, one source of variation is eliminated, leaving only the effects of environment and any genotype-environment interaction that may be present. Thus, the efficiency of the experiment is greatly increased.

While MZ twins are useful experimental animals, there are some disadvantages in their use. First, it is generally difficult to collect enough twins within a limited time for a large-scale experiment. The cost of obtaining the twins is high, and the loss of one twin may leave the other relatively useless in an experiment.

Another problem may result when both twins of a pair do not become pregnant simultaneously, because animals calving at different seasons are affected by the seasonal variation in feed supply. In lactation experiments, an additional problem lies in the various udder disturbances caused by accidental injury or infection. Treatment can arrest an infection, but its effect on lactation, and consequently the experiment, cannot be eliminated. Careful handling of the twins and good milking techniques are necessary to reduce losses.

Three kinds of experiments

Monozygotic cattle twins are generally used in three types of experiments: (1) measuring the effect of different environments, (2) measuring the magnitude of the genotype-environment interaction, and (3) estimating the heritability of traits.

MZ twins have been used to measure the relative importance of environment and heredity in accounting for production differences between herds of the same breed. At the Ruakura Research Station in New Zealand, 120 MZ sets of heifer calves were split between 20 high- and 20 low-producing herds. The average difference in milk yield between the two groups was found to be totally environmental, but about half of the difference in average fat content of the milk was genetic in origin.

MZ twins were used in Wiad, Sweden, to measure the effects of another type of environment — once-a-day milking as compared with twice-a-day milking. It was noted that increasing the interval between the night and the morning milking to 16 hours had only a slight effect on milk yield. This opened the possibility of once-a-day milking — a possibility that was supported by the discovery that some cows reacted differently to milking intervals of 16 to 18 hours.

The yield of milk and its constituents was markedly depressed when cows were milked once a day rather than twice. However, cows with high yields suffered less from the change than those with low yields. It was concluded that there are great possibilities in selecting cattle for particular milking intervals.

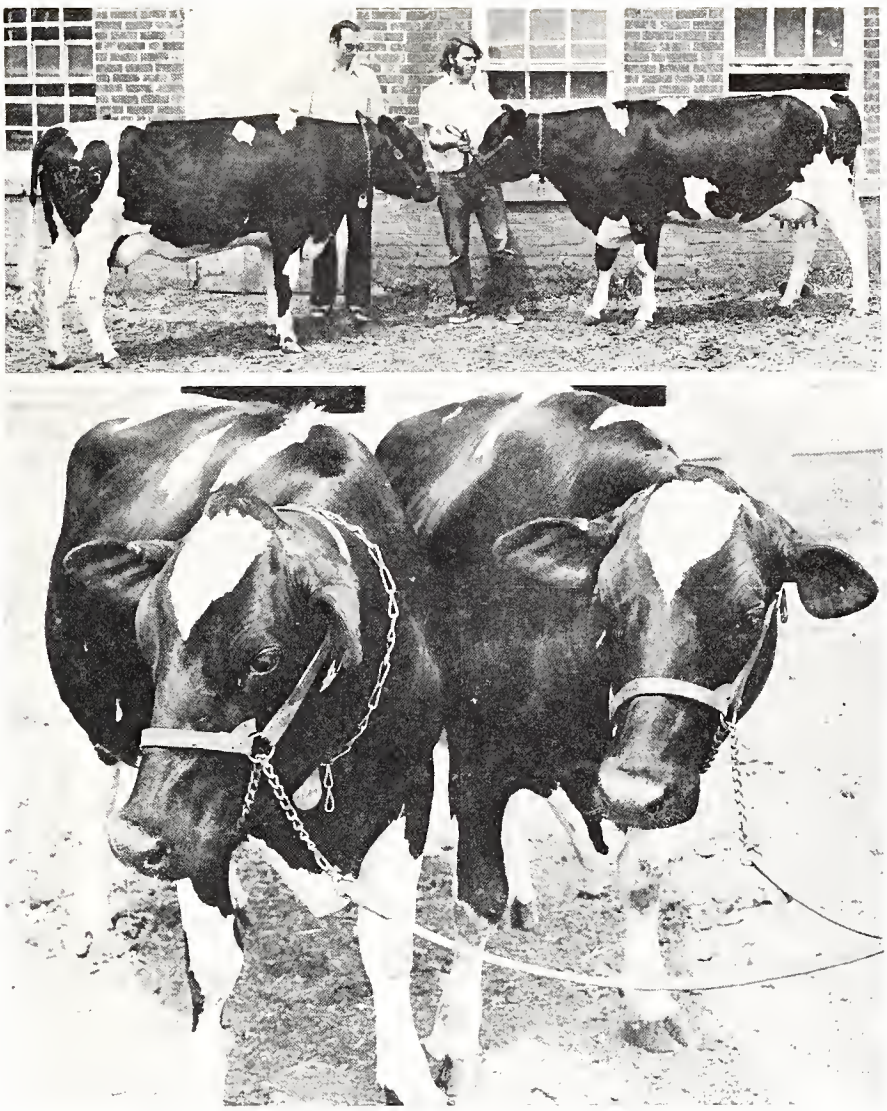
Another use of MZ twin cattle is

to study the interaction between genotype and environment by placing each twin in a different environment. If genotype-environment interactions exist, the best genotype in a given environment may not be the best in a different environment. Thus, the evaluation of cattle for a particular trait in one environment may not be a reliable estimate of their performance under other conditions.

It has been hypothesized that genotype-environment interaction could affect cattle's response to different levels of nutrition. For example, growth rate on a low plane of nutrition could be due primarily to food utilization, while growth on a high plane of nutrition could be due to appetite. This hypothesis is not valid for dairy cattle evaluation, however, according to results of a study at Iowa State University. In this study MZ twins were separated into environments with different nutritional levels. Genotype-environment interaction was found not to be important under different feeding conditions.

MZ twins have also been used in estimates of heritability. However, the estimates tend to be biased upward because twins may share common genotype-environmental interactions, as well as total genotype. Furthermore, their common environment, both prenatal and postnatal, may make them more alike and thus tend to inflate the estimate of heritability.

Some work has been done in estimating the heritability of milking rate by comparing the records of MZ twins with those of DZ twins. This procedure eliminates common environmental and maternal effects from the estimate. The milking rate of cows was found to be relatively constant over long periods and difficult to alter. The estimate derived by this comparison indicated that heritability of the trait is relatively high.



In upper picture authors M. Grossman and A. L. Kuck hold a pair of monozygotic Holstein twins. A front view of the same animals is shown in lower picture. Monozygotic twins of this breed have similar, but not identical, markings.

Current research at Illinois

The Department of Dairy Science at the University of Illinois is undertaking a research project with MZ twins involving biochemical and physiological genetic studies. Objectives are (1) to measure the amount of variation in enzyme activity and hormone levels due to genetics, (2) to estimate how the variations affect milk production and body characteristics, and (3) to determine whether the enzyme activity and hormone levels can be used as criteria for selecting breeding stock. This project involves the cooperative efforts of geneticists, nutritionists, physiologists, and other staff members.

Body measurements are being taken at 3 and 6 months of age, as well as every 6 months thereafter. In addition, each heifer is weighed every 2 weeks from the time she calves. Milk production is being recorded along with data on percent fat, solids-not-fat, and percent protein. Duplicate blood samples are being taken from each calf when it is measured, and again 1 week later. The blood serum will be analyzed for levels of hormones, and body tissues will be assayed for enzyme activities.

More twins will be needed for continuing experiments. So if you know of any Holstein twin heifers (less than 12 months old) that are for sale, please write Professor M. Grossman, 215 Animal Sciences Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801.

Energy Consumption And Return From Adding Nitrogen To Corn

R. G. HOEFT and J. C. SIEMENS

THE PRODUCTION of nearly all inorganic nitrogen fertilizers requires energy. Even though atmospheric nitrogen is abundant, it must be converted into a different form to be suitable for use as a crop fertilizer.

To produce inorganic nitrogen fertilizers, nitrogen is combined with hydrogen under high pressure and temperature. The initial product is anhydrous ammonia (NH_3). It can be either used directly as a fertilizer, or converted to other types of fertilizers such as urea and ammonium nitrate.

Most of the hydrogen for producing ammonia comes from natural gas, which has been the most readily available and most economical source. With the present shortage of natural gas, however, its use for producing fertilizer has been questioned.

Other possible sources of hydrogen include water, coal, and oil. But coal and oil are at present more expensive than natural gas, besides being energy sources; and the use of water as a source of hydrogen would require an excessive amount of energy. Shifting to one of these hydrogen sources would significantly increase the cost of nitrogen fertilizers and hence the cost of food.

An analysis of the energy consumption-return relationship provides an additional basis for evaluating the question of whether natural gas should continue to be used for producing ammonia.

R. G. Hoeft is assistant professor of soil fertility extension; J. C. Siemens, associate professor of agricultural engineering.

Energy consumption

The production of 1 ton of ammonia requires 38,130 cubic feet of natural gas, of which 22,220 cubic feet is used as a source of hydrogen and the remainder as a source of heat in the process (Table 1). In addition, 9 gallons of fuel oil and 54 kwh of electricity are required. Total energy requirement is 10.24 million kilo calories (kcals) per ton of ammonia produced, or 6,250 kcals per pound of nitrogen (Table 2).

The conversion of ammonia to other nitrogen products requires additional energy. For ammonium nitrate, the energy expenditure is 8,485 kcals per pound of nitrogen produced.

Estimated energy requirements for shipping fertilizer materials to the farm are included in Table 2. Average shipments of 1,000 miles by rail or barge and 50 miles by truck were assumed in the calculations. The energy consumed for such shipments has been reported to be 403 kcals per ton mile by rail or barge and 1,033 per ton mile by truck.

Energy requirements for applying nitrogen to the soil depend on the type of fertilizer used, not rate of application. Therefore, energy expended for application is expressed as kcals per acre. Anhydrous ammonia requires the most energy for application because it must be injected into the soil to prevent gaseous loss into the atmosphere. Other nitrogen fertilizers, both solution and solid materials, are generally broadcast on the soil surface with truck or tractor-trailer spreaders. Fuel costs do not vary between urea and ammonium nitrate (Table 2).

Energy return

Green plants are essentially the only means now available to harvest the energy of the sun. They absorb solar energy by photosynthesis and store it as carbohydrates, oil, and protein — forms of energy available for human and animal consumption.

Capture of solar energy is greatest when conditions are optimum for plant growth. Of the 16 nutrients required by plants, nitrogen is most

Table 1. — Estimated Energy Required for Producing Nitrogen Fertilizer[a]

Fertilizer material	Pct. N	Natural gas (cu. ft./ton)			Fuel oil, gal./ton	Electricity, kwh./ton
		For hydrogen	For heat	Total		
Anhydrous ammonia	82	22,220	15,910	38,130	9	54
Urea-solution	30	8,130	8,320	16,450	8	185
Urea-solid	45	12,200	13,080	27,280	12	156
Ammonium nitrate solution	21	5,690	5,200	10,890	2	115
Ammonium nitrate solid	34	9,210	10,940	20,150	8	217

[a] Source: White, W. C. Fertilizer-food-energy relationships. Illinois Fertilizer Conference Proceedings. pp. 37-43. 1974.

Table 2. — Energy Consumed in Fertilizer Production, Transportation, and Application

Fertilizer material	Kcals/lb. of N		Kcals/A. for application
	For production	For transportation	
Anhydrous ammonia	6,250	277	25,386
Urea solution	7,845	758	6,955
Urea solid	8,120	505	10,433
Ammonium nitrate solution	7,245	1,083	6,955
Ammonium nitrate solid	8,485	669	10,433

likely to be inadequate for maximum crop production and capture of solar energy. This is especially true for the three cereal crops — corn, rice, and wheat — which account for the largest energy capture and protein production worldwide.

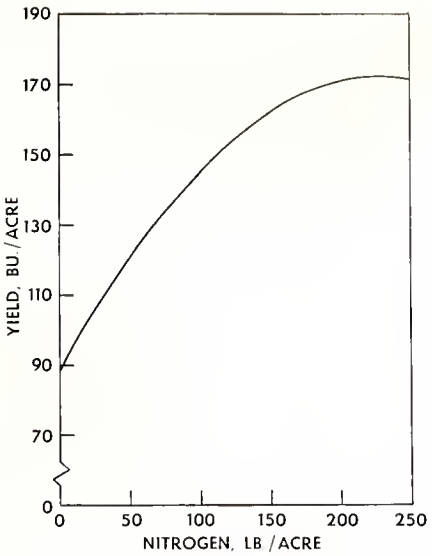
One bushel of corn results in the storage of 95,000 kcals of energy. Therefore, each pound of nitrogen applied as anhydrous ammonia must give a yield increase of 0.069 bushel to return as much energy as was expended to produce and transport the fertilizer. When dry ammonium nitrate is used, the yield increase must be 0.089 bushel for each pound of nitrogen applied. An additional yield increase of 0.267 bushel per acre is needed to recover the energy expended for applying anhydrous ammonia, and 0.11 bushel when ammonium nitrate is used.

If 100 pounds of nitrogen per acre is applied as anhydrous ammonia, a yield response of 7.2 bushels of corn would be required to obtain as much energy as was expended in producing, applying, and transporting the nitrogen.

An example of corn yield response to applied nitrogen is shown in Figure 1. Response curves such as this have been developed for soils in the Corn Belt and are used for recommending nitrogen application rates. Recommendations are at present based on economics; the recommended rate is that which will provide the maximum net monetary return per acre.

Using the example shown in Figure 1, the recommended nitrogen application rate would be about 200 pounds per acre. Additional nitrogen would increase grain yield only slightly and would not increase net income per acre at present prices.

Based on the yield response curve in Figure 1, the maximum return per unit of energy input occurred with the first 50-pound increment of applied nitrogen (Fig. 2). For anhydrous ammonia the return-to-input ratio was 8.86 to 1. Since yield response per unit of nitrogen applied decreased with increasing rates of application, the energy ratio also

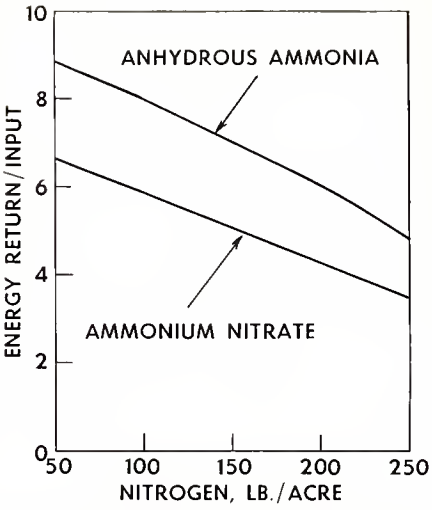


Effect of nitrogen fertilization on corn yields, Urbana, 1968-1970. (Fig. 1)

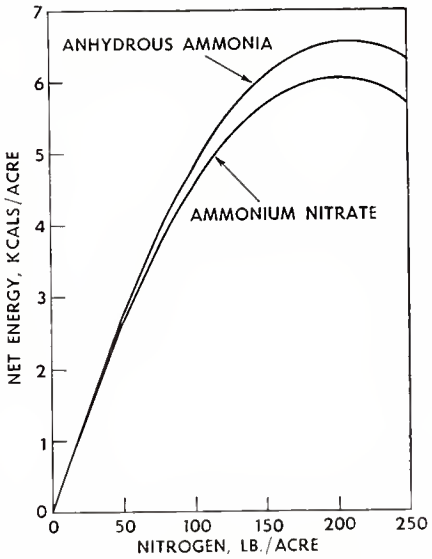
decreased. However, even with an application rate of 200 pounds per acre, which gives nearly maximum corn production, the energy ratio was 5.95 to 1.

Considering energy expended for manufacturing, transporting, and applying nitrogen, nitrogen in the form of anhydrous ammonia consumes the least energy per acre except for very low application rates. However, significant amounts of ammonia will be lost from some soils because of their physical condition. On these soils some other form of nitrogen must be used. This results in a less favorable return-to-input ratio than that for ammonia; however, it is considerably greater than 1 to 1 even for nitrogen increments near the recommended application rate (Fig. 2).

Since there is a fixed amount of land available for crop production and thus for the harvesting of solar energy, one must also evaluate the net energy production resulting from the application of nitrogen fertilizers. Although the net energy return per unit of energy expended decreases with increasing rates of applied fertilizer, the net energy return per acre increases with increasing rates of fertilizer up to the point of near maximum yield (Fig. 3). Assuming the data indicated in Figure 1, net energy of nearly 6.6 million kcals



Energy return per unit of energy input derived from applying nitrogen fertilizer to corn. (Fig. 2)



Net energy return per acre from applying nitrogen fertilizer to corn. (Fig. 3)

would be harvested from each acre of corn that had received 200 pounds of nitrogen. This amount of harvested energy would be equivalent in calories to more than 25,000 cubic feet of natural gas, 190 gallons of diesel fuel, or 7,600 kwh of electricity.

The amount of natural gas used to produce 5 tons of ammonia would heat an average home in central Illinois for a year. Converted to nitrogen fertilizer, this same amount of gas could result in enough extra corn production to satisfy the minimum protein and caloric requirements of 275 people for one year.

The Food That Cripples

When drouth destroys other crops in India, Lathyrus sativus plants produce food that averts starvation but also results in paralysis

BETTY E. HASKELL

For more than 2,000 years, man has known that eating too much of the seed of certain leguminous plants results in paralysis of the legs. The disease, known today as "lathyrism," was first described by Hippocrates. It takes its name from the plant *Lathyrus sativus,* whose seeds contain the toxin believed responsible for the paralysis.

Lathyrus peas are not cultivated in the United States, and lathyrism is not known to occur here. However, lathyrus peas are a popular food in India, and lathyrism is a serious public health problem there in some regions.

No ill effects result from eating lathyrus peas so long as the peas constitute only a small part of an otherwise nutritionally adequate diet. It is only when they are the major source of calories for three to six months that paralysis is likely to occur.

Epidemics of lathyrism are associated with drouth and famine. *Lathyrus sativus* plants are extraordinary in their ability to grow vigorously with little water. Consequently, the peas are plentiful at times when drouth-intolerant crops have disappeared from the market. It is not difficult to understand why people sometimes eat lathyrus peas in quantities sufficient to cause paralysis. They eat them when the alternative is to starve. An Indian verse praises the lathyrus peas as a life-saving food. For although the peas can cripple humans, they do not kill.

Symptoms

In a typical case of lathyrism, the victim is a young man engaged in heavy manual labor. He awakes one morning with his legs feeling weak, heavy, and tremulous. As the disease progresses, the weakness becomes paralysis. In severe cases, the knees are bent and can not be straightened. The ankles are permanently flexed. The unhappy victim must walk on tiptoes in a crouching position, supporting himself with a stick. The sight is a common one in the Rewa district in central India, where about 4 percent of the population is reported to suffer from some degree of lathyrism.

Aside from paralysis of the legs, the victim usually suffers from no other overt neurological damage. In most cases, the arms are not affected. There is no damage to sight or hearing. There are no mental changes. When death occurs, it is from causes other than lathyrus poisoning.

An obstacle to research

Why *L. sativus* seeds cause paralysis remained unknown until about 12 years ago. An obstacle to early studies was that common laboratory animals such as rats and mice are not susceptible to the disease.

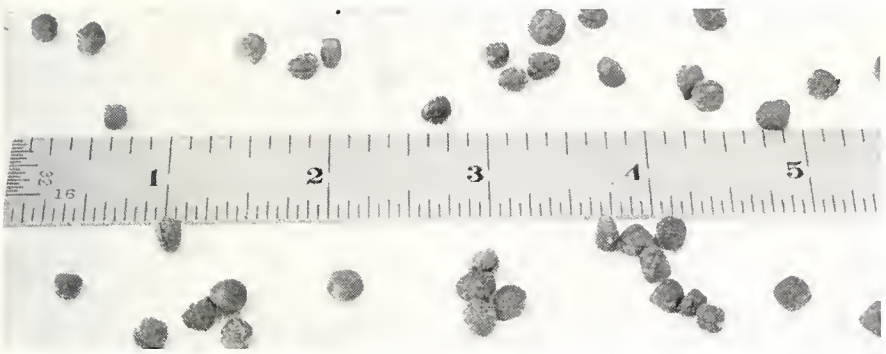
That the horse is acutely sensitive to lathyrus poisoning was discovered accidently during the late nineteenth century when a feed vendor sold Bristol Tramways and Carriage Co. some imported "Indian peas" for horse fodder. A total of 127 horses became ill from eating the peas. They collapsed, and some died of respiratory paralysis. The incident attracted considerable attention when Bristol Tramways sued the feed vendor.

Unfortunately, the horse is neither small enough nor inexpensive enough for use in a laboratory assay for a possible toxin in lathyrus peas. Nor are pigs, cattle or monkeys, the other species in which lathyrus poisoning had been reported to occur.

Significant research in India

A significant discovery by Indian researchers was that 1-day-old chicks suffer head retraction, tremors, and collapse after an injection of a crude extract from *Lathyrus sativus* seeds. Using a chick assay to test the biological potency of seed extracts, re-

Betty E. Haskell is associate professor of nutrition, Department of Food Science and School of Human Resources and Family Studies.



Toxin-containing seeds of *Lathyrus sativus* plants are about the size of peppercorns. These seeds are ground and used as a major ingredient of unleavened bread.

searchers succeeded in isolating the toxin which is now widely believed to be responsible for human lathyrism.

Discovery of the toxin was reported in 1963 and 1964 by three independent research groups: S. L. N. Rao, P. R. Adiga, and P. S. Sarma at the Indian Institute of Science in Bangalore; V. V. S. Murti, T. R. Seshadri, and T. A. Venkitasurbramian at the Indian Council of Medical Research in Hyderabad; and D. N. Roy, V. Nagarajan, and C. Gopolan at Delhi University in Delhi. These workers showed that the toxin is a low molecular weight compound similar in structure to the common amino acids which are the structural units in proteins. Chemically, the toxin is beta-N-oxalyl-L-alpha, beta-diaminopropionic acid.

It is important to note that the lathyrus toxin contains an oxalyl moiety which is easily converted to free oxalic acid, in itself a highly toxic substance. Were the neurological symptoms observed in the chick due to liberation of free oxalic acid from the toxin molecule? Dr. P. S. Sarma and colleagues answered this question by injecting into the 1-day-old chick a dose of oxalic acid equal to that supplied by 20 milligrams of toxin. (This is the amount of toxin which will produce neurological symptoms in the chick.) The oxalic acid alone had no effect. Further experiments showed that the amide bond which links oxalic acid to diaminopropionic acid must remain unbroken, or neurotoxicity of the lathyrus toxin is destroyed.

Indian investigators determined the amount of the toxin present in *Lathyrus sativus* seeds and found it surprisingly large. Depending on the strain investigated, the amount was 0.12 to 2.25 percent of the dry weight of the seed. This means that an adult human who consumed one-third of his calories as lathyrus peas might be eating several grams of the toxin per day. Epidemiological studies show that the incidence of lathyrism is highest in regions where *L. sativus* strains high in toxin are cultivated. Plant geneticists in India are investigating the possibility of reducing the toxin content of *Lathyrus sativus* to a minimum by selective breeding.

Action of the toxin

How does the toxin act? One theory, advanced by Indian investigators, is that the toxin deranges normal metabolic processes so that excessive amounts of ammonia accumulate in the central nervous system. It is the toxicity of the free ammonia which is believed to result in neurological symptoms. This theory grew out of the metabolic changes observed in brain tissue shortly after the animals had been given a dose of the toxin.

A second theory grew out of the observation in our laboratory that the lathyrus toxin behaves as an antagonist of an amino acid which may function as a neurotransmitter. A neurotransmitter is a chemical which carries the nerve impulse from one nerve cell to another (or from a nerve cell to muscle).

The discovery that the lathyrus toxin is a potent amino acid antagonist came from experiments carried out with mutant yeasts by Dr. Tara Mehta (now at M.H. College of Home Science, Jabalpur, M.P., India). She found that the toxin depressed growth when added to a chemically defined culture medium. Yeast growth could be restored completely to normal levels by adding to the medium a common amino acid whose structure is chemically similar to that of the lathyrus toxin. This amino acid is L-glutamic acid.

Further experiments by Dr. Mehta showed that the toxin is highly specific in its ability to block L-glutamic acid utilization. It is a powerful competitive inhibitor of the transport of L-glutamic acid into the yeast cell. However, it does not inhibit the incorporation of L-glutamic acid into protein. Nor does it inhibit the common glutamic acid metabolizing enzymes.

Dr. Mehta's observations were exciting because research in other laboratories had demonstrated that L-glutamic acid is a neurotransmitter in insects and in crustaceans. There is much current interest in the possibility that L-glutamic acid may also be a neurotransmitter in brain and spinal cord of animals and man.

Working in collaboration with Dr. K. Ikeda and Dr. R. Hammerschlag at City of Home National Medical Center, Duarte, California, we tested the effect of the neurotoxin on the transmission of a nerve impulse from nerve to muscle in the flesh fly. L-glutamic acid is believed to be the neurotransmitter in this system. We found evidence that the neurotoxin blocks the normal mechanism for removing L-glutamic acid from the gap between nerve and muscle. In toxin-poisoned preparations, one sees a blockade of transmission of the nerve impulse.

Does the neurotoxin accumulate in the central nervous system of humans who eat too much of the lathyrus peas? And does the toxin interfere with the normal function of L-glutamic acid as a neurotransmitter? These ideas seem interesting to us and worth further investigation.

Measuring Textile Durability

JANIS K. STONE and CAROL L. WARFIELD

We all want to know how well the numerous textiles now on the market will wear. But durability of textile products is rather difficult to define and even more difficult to measure objectively in a laboratory.

No machine now available can duplicate a person's every action and the subsequent stresses and strains to which he subjects his clothing. Some laboratory instruments, however, are designed to simulate one or more components of the types of stresses that occur during actual use and care of clothing.

One piece of equipment used to abrade or wear out textile fabrics in the laboratory is the Accelerotor (see cover). It consists of a cylindrically shaped chamber which can be fitted with a variety of liners. Depending on the type of wear to be simulated, the liner used may be one of the following: hard and smooth; emery paper over a ⅛-inch thick foam cushion which is glued to the hard smooth liner; ribbed rubber; or ribbed metal.

A blade inside the chamber, revolving at a predetermined speed, drives the fabric specimen in a zigzag pattern. This forces the fabric to rub against itself as well as against the liner, the blade, and the walls of the chamber. In addition to abrading a dry specimen, the Accelerotor chamber can be filled with water or water plus detergent. When this is done and a ribbed liner is used, the abrasive action is believed to somewhat resemble that caused by laundering.

The results of abrasion can be measured in various ways. Much of the research on this subject has focused on general fabric properties such as changes in weight, thickness, appearance, and strength after various types and amounts of abrasion. These changes, however, do not reveal what is happening inside the yarn and fabric structure. To learn more about the fabric breakdown mechanisms resulting from actual wear or from laboratory abrasion, textiles research at the University of Illinois has focused on a photomicrographic analysis of the various components of the fabric structure.

Fabric and yarn photomicrographs

Photographs may be taken of the surfaces of fabric samples to record such things as fuzzing or pilling and color change. If the photographs are magnifications of the fabric surface, they show additional details concerning yarn compaction or thinning within the fabric and shifting of the relative positions of yarns within the fabric structure.

To learn more about what happens to the fibers within the yarns after wear or laboratory abrasion, segments of the individual yarns are examined under a microscope. A series of five yarns is removed from worn or abraded fabric specimens and mounted on slides with strips of double stick tape. The yarns have to be mounted so they are straight, not twisted, and pulled taut enough to remove slack, but not so tight as to remove the crimp, or wavy pattern in the yarn.

Yarns are scanned microscopically, and both representative and unusual abrasion effects are photographed with a camera mounted on the microscope. This type of photograph (Fig. 1) enables the researcher to study the relative amounts of fiber disarray within the yarn; splitting or fibrillation of fiber ends; loosening of formerly compact yarn structures; fusing, cutting, or gouging of fibers; and progressive breakdown of the yarn itself.

Fabric cross-sections

Although the yarn photomicrographs are useful in determining what happens within the yarn itself, they do not reveal what happens in one yarn in relation to the other yarns within the fabric structure. To get this information, photomicrographs are made of fabric cross-sections.

To prepare the cross-sections, segments of worn or abraded fabric specimens are mounted in window-like frames of cardboard. The mounted specimens are placed inside large gelatin capsules. The capsules are filled with a solution of methyl methacrylate, benzoyl peroxide, and dibutyl phthalate, and baked until the solution polymerizes. The fabric sample is thus embedded in lucite (plastic).

With the use of a sliding microtome, the fabrics are sliced into cross-sections 36 microns (0.0014 inch) thick. Capsules must be carefully placed in the microtome so that the yarns in the fabric are properly aligned with the microtome blade. This is necessary so that only one crosswise yarn will be severed with each slice, giving an "in-plane" section.

Center slices of the yarns are chosen for mounting on microscopic slides because they give the best picture of what is happening in the center of the fabric. An in-plane center slice of each of six consecutive yarns is mounted on one slide. The mounting is done in immersion oil having the same refractive index as the lucite. Thus, only the cross-sections show on the slides when viewed through the microscope.

The Projectina microscope is used for studying the cross-sections. It is especially suited for this use since it has internal illumination which projects the magnified image onto a screen about 7 inches in diameter. It

The authors are both instructors in textiles and clothing, School of Human Resources and Family Studies.

can be fitted with various objectives to provide a range of magnifications.

Studying blends

In studying fabric blends, such as cotton-polyester, it is desirable to know the position of the component fibers. This is difficult to ascertain in fabric cross-sections even when magnified 400 times. However, the use of methylene-blue dye makes it possible to differentiate the two fibers, since cotton readily accepts this dye while polyester does not. The hot dye solution is applied to fabric cross-sections on microscope slides and is allowed to penetrate for one-half hour. The individual slices are rinsed in tap water, blotted, and mounted for observation.

The slices on each slide are scanned and the cross-sections that seem most representative or most unusual are photographed. Color film is necessary to show fiber patterns clearly. However, black and white photomicrographs (Fig. 2) do show gross differences in fiber content patterns.

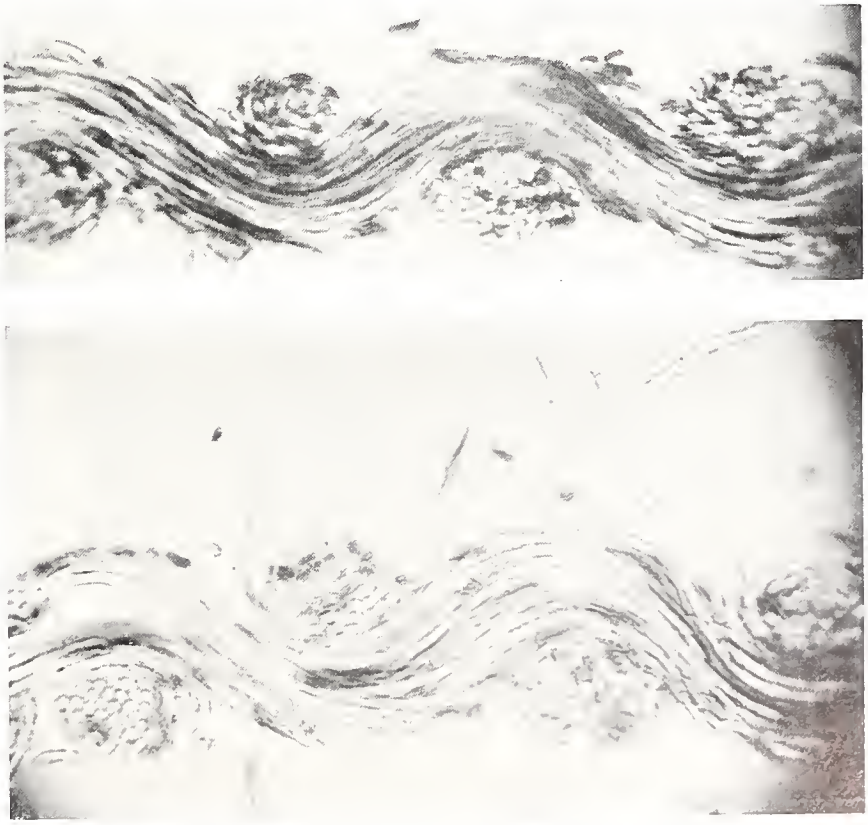
Use of the dye and a magnification of 400X has allowed clearer observation of abrasion and wear effects. Fibrillation, thought to be associated primarily with cotton fibers, has become more apparent in the polyester when the fabrics are viewed under these conditions. The powdering out of the cotton fibers in durable-press fabrics of polyester-cotton blends is evidenced by the absence of cotton in the stained cross-sections at the highest abrasion levels.

Meaning of research

By comparing the photomicrographs of yarns and of fabric cross-sections for differing amounts of wear or abrasion, it may be possible to identify the breakdown patterns characteristic of a given fabric, fiber blend level, finish, or any combination of these variables.

Analyses of fabric breakdown mechanisms do not have immediate implications for the consumer. However, it is hoped that such analyses will help manufacturers to produce fabrics, garments, and household textiles that will give more satisfactory performance during consumer use.

At left, yarn from the knee of cotton jeans laundered five times; at right, yarn from knee of jeans laundered 20 times. (Fig. 1)



At top, cross-section of a wrinkle-resistant, plain-weave fabric of 65 percent polyester (light-colored fibers) and 35 percent cotton (dark fibers) before abrasion. At bottom, the same fabric after 120 minutes of Accelerotor abrasion. Note loss of cotton from the abraded sample, loosened yarn structure, gouged fibers, and the fibrillated polyester fiber which has broken off from the structure.

No Advantage For High-Oil Corn Silage When Feeding Dairy Cows

S. L. SPAHR, J. H. BYERS, and J. H. CLARK

A RECENT development in corn breeding has been the successful selection of varieties for their high oil content. Several hybrids developed at the University of Illinois contain about 8 percent corn oil in contrast to the normal content of about 4 percent.

Because high-oil corn has a higher energy value than regular corn, it has produced more efficient gains when fed to swine. This suggested that feeding high-oil corn to dairy cows might improve milk production. According to a recent study in the Department of Dairy Science, however, cows do not derive any special benefit from consuming silage made of high-oil corn rather than regular corn.

Two silages fed to cattle

Dairy scientists grew a high-oil hybrid, harvested it for silage at the dent stage, and compared its feeding value with that of a regular corn silage (DeKalb XL-81) harvested at about the same stage of maturity.

Twenty-four cows were divided into two groups on the basis of breed, milk production, stage of lactation, and pregnancy status. Cows were fed individually and feed refusals were recorded daily. Both groups of cows were fed regular corn silage in the morning and high-oil corn silage in the afternoon for a 3-week standardization period at the beginning of the trial.

During weeks 4 to 15, one group was fed high-oil corn silage while the other group received regular corn silage. The silage was offered free choice. Each cow also was fed 1 pound of concentrate for each 4 pounds of 4 percent fat-corrected milk that she produced, plus 5 pounds of alfalfa-grass hay per day. Feed samples were collected weekly and composited at the end of the trial for chemical analyses.

Cows were milked twice daily. Milk was weighed at each milking, and milk samples were obtained at two consecutive milkings each week for milk-fat and solids-not-fat analyses. To measure the effects of the treatments, milk production during the experimental period was adjusted for initial production by covariance analysis.

Digestibility coefficients and total digestible nutrients were determined by the use of chromic oxide as an internal indicator. From day 54 to day 63 of the experimental period cows were dosed twice daily at 12-hour intervals with a gelatin capsule containing 10 grams of chromic oxide paper. From day 59 to day 63 fecal grab samples were taken twice a day at 12-hour intervals and composited for chemical analyses. Fecal samples were analyzed for chromic oxide, dry matter, acid detergent fiber, crude protein, ether extract, and ash. Treatment differences for digestibility coefficients and total digestible nutrients were tested by analysis of variance.

Table 1. — Composition of Feeds (Dry Basis)

Variable	Concentrate mixture[a]	Alfalfa-grass hay	High-oil corn silage	Regular corn silage	High-oil corn grain
Dry matter, pct.	87.0	86.2	37.1	37.0	....
Crude protein, pct.	18.8	18.7	9.5	9.3	13.8
Acid detergent fiber, pct.	4.9	35.4	26.4	24.7	5.3
Ether extract, pct.	3.1	2.5	5.2	3.4	8.3
Nitrogen-free extract, pct.	67.8	34.2	54.0	57.7	70.9
Ash, pct.	5.4	9.2	4.9	4.9	1.7
Gross energy, kcals/gm.	4,150	4,120	4,194	4,092	4,710

[a] Contoins: ground corn, 76.75%; savbean meal, 50% crude protein, 20.50%; dicalcium phosphate, 1.50%; trace mineral solt, 1.20%; vitamins A and D, .05%.

Feed composition and digestibility

Composition of the feeds is shown in Table 1. Ether extract (fat) content of the high-oil corn silage was 5.2 percent as compared with 3.4 percent for regular corn silage. The high-oil corn grain had an ether extract content of 8.3 percent, about twice as much as is usually found in regular grain. The difference between the high-oil and regular silages was less than the difference between the grains because the silage also contained the leaves and stalks.

The increased fat content of the high-oil corn grain was reflected in a higher concentration of gross energy. High-oil corn grain contained 4,710 kcals (kilocalories) per gram compared with about 4,400 kcals per gram for regular corn. Gross energy of the high-oil corn silage was slightly higher (4,194 kcals per gram) than that of the regular silage (4,092 kcals per gram).

There were no significant differences in the digestibility of the dry matter or the nutritive constituents in the diets (Table 2). Total digestible nutrient content was 64.9 percent for high-oil corn and 64.3 percent for regular corn diets.

Animal performance

Cows fed high-oil corn silage consumed 22.2 pounds of dry matter per day as silage, while cows fed regular corn silage consumed 24.0 pounds

S. L. Spahr is associate professor of dairy science. J. H. Byers (deceased) was associate professor of dairy science. J. H. Clark is assistant professor of nutrition, Department of Dairy Science.

Table 2. — Average Apparent Digestibility Coefficients and Total Digestible Nutrients[a]

Variable	Type of silage	
	High-ail	Regular
	percent	
Dry matter	62.4 ± 1.4[b]	62.2 ± 2.6[b]
Organic matter	63.1 ± 1.4	62.9 ± 2.6
Crude protein	63.2 ± 1.1	61.3 ± 2.4
Acid detergent fiber	51.9 ± 1.6	45.3 ± 3.5
Ether extract	76.1 ± 1.4	76.4 ± 1.8
Nitrogen free extract	66.9 ± 2.0	68.8 ± 2.7
Total digestible nutrients	64.9 ± 1.4	64.3 ± 2.6

[a] Differences between treatments were not significantly different (P > .05).
[b] Mean ± SEM.

Table 3. — Performance of Cows Fed High-Oil or Regular Corn Silage

Variable	Type of silage[a]	
	Regular	High-ail
Daily feed consumption (dry matter), lb.		
Corn silage	24.0 ± 1.0[b]	22.2 ± 1.0[b]
Hay	4.2 ± .1	4.0 ± .1
Concentrates	10.0 ± .3	9.5 ± .3
Daily yield, lb.[c]		
Milk	45.3 ± .7	44.4 ± .7
4% fat corrected milk	46.0 ± .8	44.0 ± .8
Solids-not-fat	3.9 ± .1	3.8 ± .1
Milk fat	1.86 ± .03	1.74 ± .03

[a] Control was DeKalb XL-81. High-oil was an experimental hybrid supplied by D. E. Alexander, Department of Agronomy, University of Illinois.
[b] Mean ± SE.
[c] Adjusted by covariance for production during the second and third weeks of the standardization period.

per day (Table 3). Body weight changes were similar for each group.

The yield of 4-percent fat-corrected milk was 46.0 pounds per day for cows fed regular corn silage compared to 44.0 pounds for cows receiving high-oil silage; this difference was not significant. Actual milk production was 45.3 pounds per day for cows fed regular corn silage and 44.4 pounds for cows receiving high-oil corn silage. Daily yields of solids-not-fat and fat were approximately the same for both groups.

These data indicate there was no advantage to making silage from high-oil corn varieties even though the ether extract and gross energy contents were slightly higher than for regular corn. The diluting effect of parts other than the kernel of the corn plant and the feeding of concentrates and hay as part of the diet apparently counterbalance the additional energy in high-oil corn silage.

It appears that high-oil corn will have its place for feeding nonruminant animals and in the food-processing market. However, any advantage the high-oil content of corn silage may provide for ruminants is easily offset by feeding an extra pound per day of concentrates or hay.

BEEF ROLL BINDING STRENGTH

As Affected by Amounts of Salt And Phosphate and by Mixing Time

GLENN SCHMIDT

COOKED BEEF ROLLS are widely used in institutional feeding because they have excellent portion control and a uniform composition. They also have the taste and textural properties of beefsteak although they are usually prepared from the lower grades of beef.

The rolls are made by mixing chunks of beef, ground beef, salt, phosphate, water, and seasoning. There has been some concern that the rolls may add too much salt and phosphate to the diet. A study is therefore under way in the Department of Animal Science to determine how beef rolls can be made with the least amounts of additives.

So far preliminary experiments have been conducted to determine the effects of mixing time, salt, and phosphate on binding strength and cook yield. Hot-boned beef has also been compared with cold-boned beef.

Glenn Schmidt is assistant professor of animal science.

Treatments

Four treatments were studied — hot- and cold-boned beef mixed with salt and salt-phosphate solutions. The treatments were repeated three times, so all together 12 individual batches were made. A third of each batch was mixed 5 minutes; a third, 10 minutes; and a third, 20 minutes.

Each batch weighed 18 kilograms and consisted of 90 percent beef and 10 percent salt solution. The salt solutions were composed of either 1 percent sodium chloride and 9 percent water or 1 percent sodium chloride, 0.25 percent Heller's Soluble Phosphate, and 8.75 percent water.

To make the hot-boned rolls, beef rounds were ground through a 2.54-centimeter plate (resulting in chunks about 1 inch square), combined with the salt solutions, mixed for the specified time, stuffed into casings, and placed in a cooler within 5 hours after the cattle were slaughtered. Cold-boned rolls were made the same way, except that the sides of beef were held for five days at 2° C. before they were boned.

All rolls were chilled to 2° C. before cooking. They were cooked in a water bath of 85° C. to an internal temperature of 68° C., then chilled again to 2° C.

Tests conducted

Casings were removed from the chilled rolls and the rolls were wiped dry before they were placed on the base of the breaking apparatus. This apparatus was composed of two units

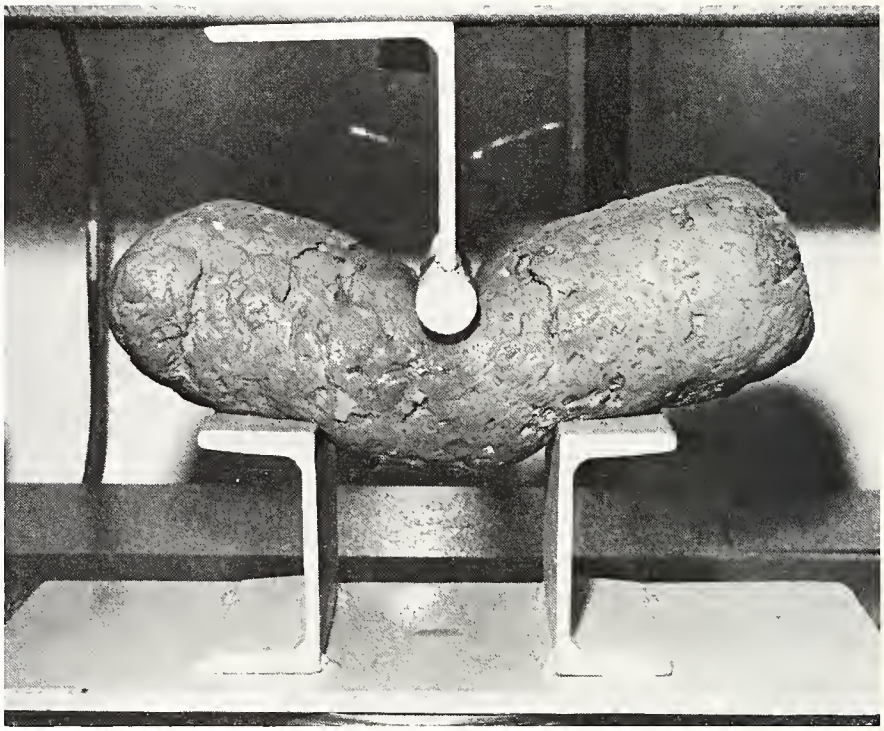
— the base and the breaking bar assembly.

An Instron Universal Testing Machine was used to determine and record the pressures necessary to break the beef rolls. Both the base of the breaking apparatus and the roll were placed on the pressure-sensitive platform of the Instron unit and zeroed. The breaking bar was bolted to the mobile arm of the Instron.

The circumference of the roll was measured at the point where the breaking bar would apply pressure. The breaking bar traveled at a rate of 2 centimeters per minute and the chart at a rate of 1 centimeter per minute.

Pressure was applied until the roll broke, after which the maximum pressure that was applied was recorded. The maximum pressure per square centimeter of the cross-sectional area expressed the binding strength of the roll.

The roll was weighed and the cook yield was determined. All rolls were analyzed for moisture, ether-extractable materials, protein, sodium, and phosphate.



A beef roll is placed on the breaking apparatus and force is applied by the Instron Universal Testing Machine.

Some comparisons

Salt-phosphate-treated rolls (both hot- and cold-boned) had higher binding strengths and higher cook yields than the corresponding salt-treated rolls (see table).

Hot-boned rolls had higher cook yields and lower binding strengths than cold-boned rolls in both salt and salt-phosphate treatments. Although lower in binding strength than the cold-boned rolls, the hot-boned rolls were still quite acceptable in firmness and texture. Since the hot-boned rolls also had higher cook yields, they would be generally more desirable than the cold-boned ones.

In all four treatments, binding strength generally increased with increased mixing time. However, mixing time had little effect on cook yield.

The Effect of Hot-Boned Meat on Properties of Beef Rolls

Treatment	Mix time, min.	Instron, gm. per sq. cm.	Cook yield, pct.	Water, pct.	Fat, pct.	Protein, pct.	Phosphorus, pct.	Sodium chloride, pct.
Salt, 1 pct.								
Hot-boned	5	149	88.4	66.7	11.5	20.3	.15	1.2
	10	187	88.0	64.4	13.3	20.5	.16	1.1
	20	236	88.8	65.1	12.5	20.4	.16	1.3
Cold-boned	5	221	77.9	63.8	13.1	18.2	.14	1.2
	10	293	78.8	63.9	13.3	19.7	.15	1.1
	20	314	78.4	65.6	10.1	20.9	.15	1.1
Salt, 1 pct. Phosphate, 0.25 pct.								
Hot-boned	5	255	92.2	63.7	16.4	17.7	.20	1.6
	10	297	92.6	66.8	11.5	19.9	.22	1.6
	20	317	95.3	67.5	11.5	17.9	.22	1.7
Cold-boned	5	372	84.5	64.0	14.1	19.4	.20	1.4
	10	294	84.0	64.8	12.5	19.7	.19	1.3
	20	433	86.3	65.7	11.4	19.4	.20	1.3
Overall mean								
Hot-boned		190**	88.4**	65.4	12.4	20.4	.16	1.2
Cold-boned		276**	78.4**	64.4	12.1	19.6	.15	1.1
Salt-phosphote								
Hot-boned		290*	93.4**	66.0	13.1	18.5	.21	1.6
Cold-boned		367*	84.9**	64.9	12.7	19.5	.20	1.3

* Significant difference at the 5-percent level between rolls prepared with hot- and cold-boned meat.
** Significant difference at the 1-percent level.

These results will be used as a base line for further experiments to determine whether compounds or physical treatments can be used to reduce the amounts of salt and phosphate required to make this restructured meat product. The information obtained thus far suggests that it will indeed be possible to make a beef roll that has a desirable texture and a high cook yield without adding large amounts of salt and phosphate.

A New Record Book for Pork Producers

V. D. LADWIG and J. W. JUDY, JR.

GOOD RECORDS are very important in pork production. Unfortunately, many of the record systems now available are too complicated and inconvenient for easy use by either the producer or the veterinarian. On the one hand, they require unavailable information, while on the other hand, they do not provide useful herd health data.

In an effort to overcome the disadvantages of current systems, we have developed a "Herd Health Maximization" record book. Problem identification and problem solving are the basis of entry.

Once established, the records are invaluable in relating productivity to herd health. They assist in detecting subclinical disease and infertility problems, and ultimately are used to improve management and develop a herd health maximization program. Written recommendations remind the owner of the counsel he has received.

The first section of the record book is the problem list. Each problem that has been identified is described and assigned a number, and the date of occurrence is recorded. There is also space for recording the date of resolving the problem. The problem number is the key to the simplicity of further record keeping throughout the book.

Section two provides space for listing each treatment, the date, the group treated, subsequent observations, and the initials of the person who made the treatment.

Section three, entitled "Recommendations," includes the advice given to the operator. Columns are provided for recording the problem number, the date, the recommendations made, and the action taken by the owner in response to the recommendations. This is a very effective method of reminding the producer to carry out the instructions given.

Section four, "Action taken by the owner," describes the activity of the producer as he is resolving a particular problem. Again the problem number is used as identification.

Section five provides for a cumulative record of diseases affecting the herd. Diseases are identified by problem number, the date they occurred, and any vaccination or treatment that was administered.

This section also contains room for a map of the building arrangements, as well as a complete description of each building in the production unit. Included in the building description are dimensions, pen size, square feet per animal, general structural characteristics of the building, feed handling, waste disposal, animal flow through the building, and any additional information that will help the veterinarian review the adequacy of the facility.

Section six is a record of deaths, including observations by the owner or veterinarian and reference to the problem number. All bacterial isolations made and antibiotic sensitivity tests conducted are recorded, along with the problem number and date.

Section seven is concerned with feed, but only as changes are made in the source of supply, quantity fed, or quality. In Illinois, the Farm Business Farm Management record systems adequately identify feed costs as they relate to production. If, however, a record system for feed costs is not in use, one can be incorporated into the health maximization record system. Since feed costs are a measure of the health in the production unit, the information should be available.

Section eight is for recording reproductive efficiency and growth rates. It includes columns for identifying specific sows and indicating breeding dates, although this information is not readily available for most production units.

Other columns are based on Leman's and Mueller's suggestions for obtaining meaningful data: (1) Make a monthly inventory of the sows and gilts in the breeding herd, including gilts saved for breeding after they reach 6 months of age. (2) Record the number of pigs farrowed each month. (3) List the pigs' condition at birth, including mummies and stillborn. (4) Record the number of pigs weaned in the month. These monthly observations can be used to calculate the pigs per female month. To do this, the number of pigs weaned in a month is divided by the number of female months (total females in breeding herd during the month). One pig weaned per female month is an acceptable goal.

Growth rate is an important monitor of the time required to get an animal to market weight and indirectly is a measure of feed efficiency. Records over a year or more will clearly indicate if problems exist as a result of disease, crowding, inadequate feeder space, or a host of other possible causes. While it is desirable to use weighing or measuring devices to monitor feed efficiency in some groups of pigs, it is not practical in most commercial production units to monitor feed usage in all groups.

Section nine is a record of animals purchased and brought into the herd. The introduction of new animals is important because they are a common source of disease. Data about the animals' origins, testing procedures, and isolation are listed and can serve as a reference.

In summary, information that is most important to herd health maximization is recorded in this book. The assignment of a number to identify the problem, and the use of this number in all the records make for a simplicity that is acceptable to veterinarians and producers.

V. D. Ladwig is assistant professor of veterinary medicine administration; J. W. Judy, Jr., is acting head of the Department of Veterinary Clinical Medicine.

FARM BUSINESS TRENDS

Variations in weather conditions bring profits or losses to farmers — and food or famine to man and beast. Thus, weather trends may have a strong influence on farm businesses and food supplies during the next few years.

There are at least four explanations of weather developments during recent years, and hence four projections about weather conditions and food production during the years just ahead.

One view is that our midwestern weather runs in a 20-year cycle. Those who hold this opinion cite the fact that the 1930s and the 1950s were dry. Hence, they expect the 1970s to be drouthy also. The past growing season was, indeed, very dry in the great plains.

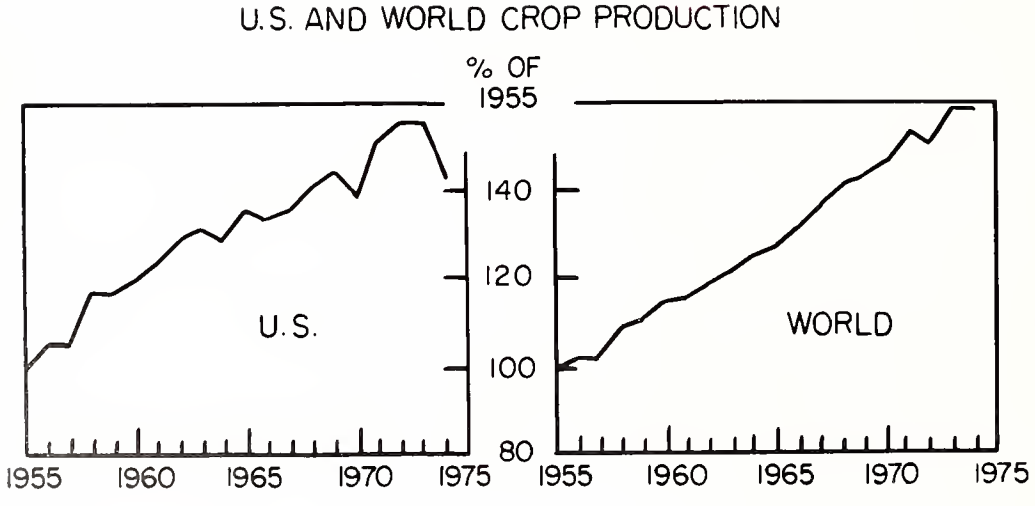
A second group of weather observers do not hold to the 20-year cycle, but believe that world-wide weather conditions were unusually favorable for crop production during the 1950s and 1960s. They do not anticipate such favorable conditions during the 1970s, but expect a return to more normal (less favorable) weather. Certainly 1972 was the worst year for world crop production in at least two decades. There was some recovery in 1973, but extensive crop failures again in 1974.

Some climatologists believe that the world's weather is undergoing a major change that will restrict crop production for several years. They point out that what appear to be relatively small changes in temperatures and rainfall can have a surprisingly large impact on food production.

While these three groups of weather analysts have different explanations for changing weather patterns, they reach a similar conclusion: Climatic conditions are not likely to be so favorable for crop production in the next few years as they were during the 1960s.

There is one other opinion: It is that weather changes have not had a major impact on agricultural output and prices in recent years. Those who hold this view see no reason to believe that changes in climatic conditions will be a major determinant of food production during the remainder of the 1970s.

It appears that "... the last word lies with the God of weathers ..." — *L. H. Simerl*



Unfavorable weather conditions caused the dips in crop production shown at left. U.S. production sagged in 1970 because of the weather-related southern corn leaf blight, and in 1974 because of excessive rains at planting time, drouth during the growing season, and early freezes. World production dipped in 1972 owing to poor growing seasons in Russia, Asia, Africa, and several other parts of the world.

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSU

Months of enjoyment yours when you grow y own vegetables (page 8).

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ILLINOIS RESEARCH
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CONTENTS

(Cover picture courtesy of Burpee Seeds)

CORRECTION: On page 11 of the Winter issue, the vertical axis of Figure 3 should read "million kcals/acre" instead of "kcals/acre."

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COUNCIL ON ENVIRONMENTAL QUALITY UPDATE

SOME CHANGES have been made in the College of Agriculture Council on Environmental Quality since it was organized in 1970. However, the purpose of this interdisciplinary-interdepartmental Council remains the same: to aid the Director in assessing needed interdisciplinary research on environmental problems, developing and evaluating alternative proposals, and exploring new sources of financial support.

Each member of the Council is chairman of a task group that is examining some particular aspect of the environment. Originally, there were eight task groups:

Pesticides and Pest Control Systems
Plant Nutrients as Water Pollutants
Animal and Human Metabolic Wastes
Plant Residue and Food Processing Wastes
Erosion and Sedimentation
Extension Education and Public Service
Human Interaction With the Physical Environment
Decision-Making Related to Environmental Quality

In 1974 the task groups were restructured. The animal and human wastes group was split into two. Two new task groups were formed: Reclamation of Strip Mined Land and Mine Refuse; and Energy Capture, Conversion, and Utilization in Food Production and Use. At the same time, the human interaction group was discontinued. Extension Education and Public Service was also discontinued as a separate unit, but an extension specialist was added to each of the other task groups.

The task groups include nearly 100 scientists involved in a variety of research projects. The Fall, 1970, issue of ILLINOIS RESEARCH was devoted entirely to reports about some of these projects. Further reports have appeared from time to time in subsequent issues, including this one, and more may be expected in the future. — *G. W. Salisbury*

ALFALFA WEEVIL CONTROL:

Better Results With Less Insecticide

W. G. RUESINK, D. P. BARTELL, and E. J. ARMBRUST

THE MOST SERIOUS pest threatening alfalfa in Illinois is the alfalfa weevil, *Hypera postica* (Gyllenhal). A native of the Old World, this weevil was first discovered in 1904 near Salt Lake City, Utah. For nearly 50 years it remained confined to 12 western states. In 1952, however, it was discovered in Maryland and from there it has spread rapidly through the East, South, and Midwest.

Most researchers believe that the 1904 and 1952 discoveries represent populations of two different, but morphologically indistinct, strains; the eastern and the western. The eastern strain is the one found in Illinois. Since its first appearance here 10 years ago, it has spread to every county of the state.

Life cycle

First-generation adults (Fig. 1) emerge in the spring, feed for a short time, and then fly from the alfalfa to woodlands, fence rows, and other protected areas, where they enter aestivation (a resting period). In Illinois most of these adults return to the alfalfa in late summer or early fall and complete their sexual development.

In southern Illinois, if temperatures permit, the weevils lay eggs throughout the fall and winter, as well as into the spring. The fall- and winter-laid eggs hatch about the time that alfalfa is beginning its spring growth, and the tiny first-instar larvae feed on the young plant tips.

In the more northern counties egg laying stops or slows down during the winter, depending on temperatures, and a larger number of eggs are laid in the spring. The eggs hatch much later than in the south. By the time the larvae emerge, the alfalfa is 6 to 10 inches tall and can tolerate more weevils than can the southern crop.

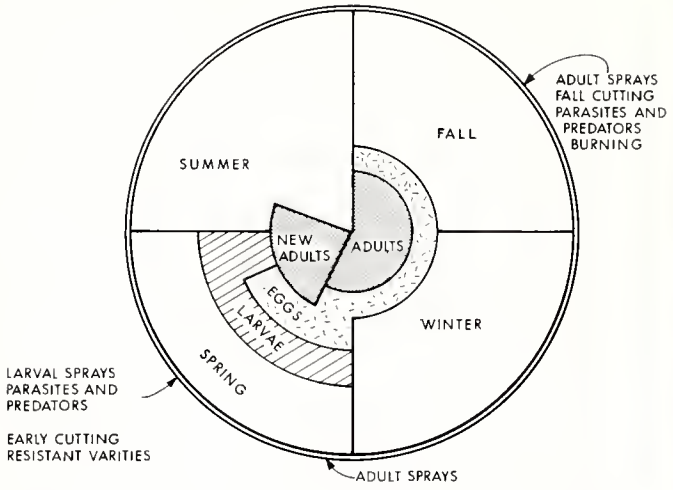
Life stages of alfalfa weevil and its larval damage. Left, top to bottom: pupae, larvae, damage to plant tips. Right: eggs within stem, adults. (Fig. 1)

Control necessary

In many regions of the state, alfalfa production is almost impossible without some type of weevil control. Although chemical control has been the most widely used method, two other methods are common (Fig. 2).

One method is to manipulate the

The authors are entomologists with the Illinois Natural History Survey and Illinois Agricultural Experiment Station. This research was supported in part by a grant (NSF GB-34718) from the National Science Foundation and Environmental Protection Agency.



Alfalfa weevil life cycle and possible control tools used during each season. (Fig. 2)

Adult and cocoon of the wasp, *Bathyplectes curculionis*, an effective parasite of the alfalfa weevil. (Fig. 3)

timing of the first harvest in the spring. After considering many factors such as size of the pest population, plant growth, and prevailing weather conditions, the grower can time the cutting date so that he can achieve the same effect as if he had applied an insecticide.

The other method involves biological control agents, such as parasites and predators. One of the most successful biocontrol agents in Illinois is a small parasitic wasp, *Bathyplectes curculionis* (Fig. 3). This wasp lays its eggs inside young weevil larvae. The wasp larvae develop inside the weevil larvae and when they have satisfied their needs, they kill their hosts.

Interdependence

The principal reason that we have a research program on alfalfa weevil control is that the three control methods — chemical, cultural, and biological — are interdependent. For example, insecticides kill parasites and predators as well as alfalfa weevils. Similarly, harvesting alfalfa when many of the weevil larvae are parasitized will reduce the parasite population.

Further, the economics of considering three control methods simultaneously is complex. A slight change in cutting dates may slightly reduce yield, but if the change benefits the biological control agent and reduces the weevil population, it may be financially advantageous.

Mathematical models

Mathematical models are now being constructed to answer some of the complex questions resulting from the three methods of weevil control. Entomologists at the Illinois Natural History Survey and the Illinois Agricultural Experiment Station are cooperating with their counterparts in seven other states in developing these models.

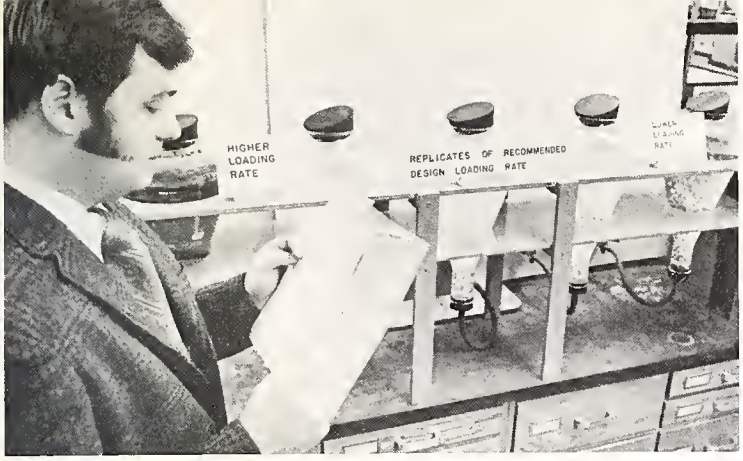
The modeling effort is being supported by three kinds of biological research. One kind involves periodic sampling of the alfalfa weevil population. This provides a data base against which to validate the models being developed. For the past year samples have been taken, sometimes as often as twice a week, from six fields in Washington County. The sampling is being restricted to this one area to reduce travel time and costs. After the samples are processed in our laboratory in Urbana, the resulting data are entered into files in the University of Illinois's IBM 360 computer.

Another kind of research concerns the population dynamics and the behavior of *B. curculionis*. We are looking at such things as survival of parasite cocoons (overwintering stage), longevity of adult parasites, and their reproductive potential.

In the third kind of research, we are developing new and improved techniques for measuring population densities of the alfalfa weevil and *B. curculionis*. The purpose is to be able to forecast the best combination of control methods for a particular field. A technique of sweep net catches of adult weevils is now being studied.

The data from these three research areas are being analyzed and utilized along with other published and unpublished data to develop mathematical and computer-based models. Individual models of alfalfa weevil population dynamics, parasite and predator population dynamics, alfalfa plant growth dynamics, and economic decision-making processes are being tied together into a comprehensive strategy-decision model. This model will tell us how to use insecticides and how to adjust cutting dates to achieve the best possible management of the alfalfa weevil with maximum benefit to the grower, as well as to society in general.

During the coming years, we expect to complete the validation of our preliminary models and use them to manage alfalfa production in our study fields. If successful, the program will be expanded to fields in other parts of the state and finally made available to all Illinois growers via the Cooperative Extension Service.



Mr. Winters with laboratory digesters used for aerobic treatment of swine wastes.

Assessing the Feeding Value Of Treated Swine Wastes

C. W. WINTERS and D. L. DAY

A NEW laboratory technique for assessing the protein content of treated animal wastes is being investigated in the Department of Agricultural Engineering. The investigation is part of a continuing study of swine oxidation ditch recycling.

Both protein and minerals that can be refed as a supplement in a balanced ration have been found in aerobically treated ditch contents, called oxidation ditch mixed liquor (ODML). Most of the protein lies in the portion of ODML that passes through a 200-mesh sieve, indicating that the microbial population is responsible.

Problems in measuring protein

To develop a workable program for refeeding, animal scientists need to know the quantity and quality of ODML that can be extracted from an oxidation ditch operating under specified conditions. Of course these conditions — particularly those favoring protein production by microbes — must be optimized.

The model for optimizing protein yield is an empirically developed relationship between biological growth and substrate utilization that is commonly used for biological systems stabilizing organic or inorganic wastes. To use this model, one must know the concentration of living microorganisms in the ODML.

At present, the most common method of estimating the microbial population in any waste sludge is by the mixed liquor volatile suspended solids (MLVSS) determination. This test is inadequate, however, because it measures dead organisms and nonbiodegradable volatile solids, as well as live organisms. The combined living and dead organisms could be separately determined by measuring the deoxyribonucleic acid (DNA) content, but there still would not be a distinction between living and dead cells. Biologically the living cell concentration could be determined by the Warburg technique for measuring oxygen uptake, but this technique requires specialized equipment and skilled technicians.

Value of new technique

It was to overcome the difficulties of measuring live cells that we tried a new technique. Actually the technique is an adaptation of one that was developed on anaerobic stream bed deposits in Europe and on municipal activated sludge in the United States. Known as the dehydrogenase enzyme activity test, it is a chemical method for determining viable cells.

The dehydrogenases are a group of enzymes that break down organic compounds biochemically, with hydrogen atoms as a by-product. In fact, they catalyze the removal of hydrogen atoms from the organic substrate, with most of the enzymes having coenzymes that serve as temporary acceptors of the hydrogen. Each dehydrogenase is usually quite specific to its organic substrate and also to the coenzyme that it requires. The activity of the various dehydrogenases is therefore a good indicator of biochemical activity.

The enzymes can be easily measured by placing a hydrogen acceptor in the solution. In this particular case the acceptor is a tetrazolium salt (triphenyltetrazelium chloride, or TTC). This salt, originally colorless, turns red in its reduced form (triphenyl formazan, or TF). The intensity of the red color is taken as a measure of dehydrogenase activity. Thus a simple physical measurement by a calibrated spectrophotometer can yield the concentration of viable cells in a sample of swine ODML.

But since this is a biochemical reaction, several factors affect the test. The pH of the test solution must be maintained by utilizing a buffer. Temperature during the reaction must be held constant by a water bath. Incubation time for each test, which is about 15 minutes, must be duplicated exactly for each sample. The substrate, which in this test is glucose, and the TTC salt must be added to the ODML in excess to insure that the substrate and the hydrogen acceptor are not limiting factors. Laboratory testing of these variables has established the proper levels of each.

Although the dehydrogenase activity test was designed to measure the higher levels of microbial activity in an activated sludge system, it has been successfully adapted to yield reliable results throughout the range of activity in swine ODML. It is hoped that the technique will gain favor with other animal waste researchers as a new tool in the quest for producing feedstuffs more economically while protecting the environment from otherwise waste products.

C. W. Winters is a farmer research assistant; D. L. Day, a professor of agricultural engineering. This article is based on Mr. Winters' M.S. thesis.

The Nitrate Controversy:
Three Proposed Policies And Their Economic Effects

C. ROBERT TAYLOR

THE NITRATE concentrations in Illinois water supplies continue to inspire heated debates. Some of the controversy centers around the potential harmfulness of these nitrates, particularly to human and animal health. Other debates concern the possible link between the use of nitrogen fertilizers and the nitrate concentrations in streams. Circumstantial, though not definitive, evidence indicates that such a link may exist.

This article is not concerned with these controversies. Rather, its purpose is to examine the economic effects of some proposed policies for regulating the use of inorganic nitrogen fertilizer. This economic information can be synthesized with definitive information on physical and biological relationships, when it becomes available, to establish the economic trade-offs involved in reducing nitrates to various specified levels.

Three policies

Three proposed policies are considered here: (1) restrictions on the use of nitrogen fertilizer per acre; (2) an excise tax on nitrogen fertilizer; and (3) a market for rights to use nitrogen fertilizer.

Other alternatives which have been proposed, but which are not considered here, are: (1) protection of nitrogen-sensitive individuals, particularly infants; (2) removal of nitrates from drinking water or even entire rivers; (3) growing cover crops for corn; (4) adjusting the timing of nitrogen applications; and (5) various combinations of the above alternatives.

Since a "market for rights" may be unfamiliar to some, it deserves a word of explanation. One possible arrangement would have these basic attributes: (1) Rights to apply nitrogen fertilizer would be issued every year. (2) A public agency, such as the Illinois Environmental Protection Agency, would decide annually upon the desired water quality and thus the desired number of rights to issue. (3) With rights issued periodically, it would be possible to change water quality over time. (4) Trading in rights could begin with the public agency asking each user to indicate the quantity he would order at various prices. The agency could then select the price at which the total quantity ordered would be closest to the desired number of rights. After rights were issued, individuals could buy and sell them among themselves, with the agency functioning only as an information center.

With this system, individuals or groups would have two ways of influencing the amount of fertilizer used: They could try to change the number of rights through the political system. Or they could buy rights and, by not using them, keep that amount of fertilizer from being applied. With an excise tax or a per-acre restriction, the only way to influence the regulation would be through the political system. In the following discussion, it is assumed that non-users do not purchase any rights.

Effects on farm economy

The predicted effects of the three policies on the farm economy are based on an environmental policy model of crop production in the United States. A comparison of a benchmark solution of this model with actual acreages in 1970 suggests that it reasonably reflects crop distribution in the United States. It should be noted that many assumptions, too numerous to mention here, underlie the model and may critically influence the predicted effects of any policy.

Shown in the table are the income, acreage, and fertilizer-use effects of three per-acre restrictions (150, 100, and 50 pounds), two excise tax levels (12 cents and 24 cents per pound of elemental inorganic nitrogen), and the issuance of two levels of nitrogen fertilizer rights (equivalent to 672 and 395 million pounds of elemental inorganic nitrogen fertilizer). Results are based on the assumption that each policy is imposed only in Illinois with no changes in the fertilizer policy in other states.

For the per-acre restrictions, it is assumed that producers who have been applying more than the restriction level will reduce their application to that level, while those who have been applying less will not change their practice. It is further assumed that phosphorus and potassium fertilization practices remain unchanged.

Per-acre restrictions of 150 and 100 pounds do not significantly affect corn and soybean acreage in Illinois or in other Corn Belt states (see table). However, both restrictions influence farm income and nitrogen fertilizer use in Illinois. Net farm income in Illinois would increase by a very small amount (0.4 percent) under the 150-pound restriction, primarily because over-application of

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Effects of Imposing Various Nitrogen Fertilizer Policies in Illinois

Policy	Changes in Illinois						Changes in other Corn Belt states[a]	
	Per-farm income[b] (pct.)	N fertilizer/A. on corn (pct.)	N fertilizer/A. on wheat (pct.)	Total N fertilizer used (pct.)	Corn acreage (mil. A.)	Soybean acreage (mil. A.)	Corn acreage (mil. A.)	Soybean acreage (mil. A.)
Per-acre restriction								
150 lb./A.	+0.4	−10	−2	−9	+0.03	+0.02	−0.1	+0.1
100 lb./A.	−4.0	−30	−10	−29	+0.04	+0.03	+0.03	+0.3
50 lb./A.	−17.0	−62	−39	−81	−5.7	+4.4	+3.6	−4.4
Excise tax								
12¢/lb.	−9.6	−25	−40	−61	−5.7	+6.6	+4.6	−5.7
24¢/lb.	−12.3	−32	−60	−76	−7.7	+8.8	+6.0	−7.8
Issuance of rights								
672 mil. lb.	−9.6	−25	−40	−61	−5.7	+6.6	+4.6	−5.7
395 mil. lb.	−12.3	−32	−60	−76	−7.7	+8.8	+6.0	−7.8

[a] Missouri, Indiana, Iowa, and Ohio.
[b] From corn, soybeans, wheat, and oats.

nitrogen fertilizer on corn would be reduced to more economic levels. About 33 percent of the farmers, those now applying more than 150 pounds, would be forced to reduce their application rates. Although the mean nitrogen fertilization rate on corn in Illinois is already below 150 pounds per acre, the mean per-acre rate would be reduced by 10 percent if everybody were restricted to 150 pounds.

The restriction of 50 pounds per acre substantially affects crop acreage, income, and fertilizer use. After adjustments are made, this restriction would decrease corn acreage in Illinois by about 5.7 million acres and increase soybean acreage by about 4.4 million acres. These shifts would be roughly offset by opposite acreage shifts in other Corn Belt states. The 50-pound restriction would reduce net income per farm in Illinois by 17 percent.

While per-acre restrictions would clearly reduce the intensity of fertilizer use, they might not necessarily reduce total use because an acreage increase might more than offset the reduced intensity. However, under all three per-acre restrictions, total use would decline.

An excise tax of 12 cents per pound would have the same effect on the farm economy as the issuance of 672 million pounds of rights, and a tax of 24 cents per pound would have the same effect as the issuance of 395 million pounds of rights. The reason is that 672 million pounds of fertilizer would be bought under the 12 cents tax policy and 395 million pounds, under the 24 cents tax. All the tax and rights policies decrease farm income in Illinois, they reduce both per-acre and total use of fertilizer, and they result in a shift from corn to soybeans in Illinois.

As mentioned previously, rights policies differ from tax policies in that non-users have different options for influencing the amount of fertilizer used. Another important difference is that a public agency could control total fertilizer use much more precisely with the rights policy than with the tax policy. This is true because export demand, domestic demand, and many other factors could greatly influence the amount of fertilizer purchased under a given tax rate. Unless the agency could anticipate these changes and adjust the tax rate accordingly, it would be impossible to precisely control total nitrogen use under the tax policy. Therefore, if the nitrate concentration in water supplies has a positive relationship to total fertilizer use, and if a standard on nitrate concentration must be enforced, the rights policy is superior to the tax policy.

Administrative considerations

Although data are not available on administrative costs, the per-acre restriction apparently would be much more difficult and costly to enforce than either of the other two policies, because the administering agency would have to police the restriction over most of the land area in the state and check on a large number of farmers.

Although the tax policy or the rights policy would apparently be less costly to administer, there would be an economic incentive to "bootleg" fertilizer from surrounding states. It would likely take the cooperation of fertilizer dealers in other states and an elaborate computer-assisted checking system to achieve an acceptable degree of compliance with these policies.

Any of the tax or rights policies discussed here would generate about $80 million in revenue. This could be used to pay administrative costs and such other costs as compensating individuals who were particularly hard hit by the policy.

Integrated policies desirable

An extremely important aspect of imposing any of the policies only in Illinois is that total nitrogen fertilizer use in other Corn Belt states is increased because corn acreage is increased. Thus, if the nitrate concentration in water supplies has a positive relationship to total nitrogen fertilizer used in a particular area, nitrate problems will be increased in many other states. A national nitrate policy which allows for regional differences in physical and technical relationships as well as interregional economic interrelationships would therefore seem to make sense.

It would also be advisable to evaluate nitrogen policies in connection with other agricultural pollution policies, because the policies may have interactive, not simply additive, impacts. Constraints are now being seriously considered on such aspects of agricultural production as pesticide use, animal waste disposal, and land use.

Future research will be directed toward simultaneously evaluating a complex of policies related to both real and hypothetical pollution resulting from agriculture.

Eat Well and Save Money By Growing Your Own Vegetables

J. S. VANDEMARK, H. J. HOPEN, and J. W. COURTER

THIS YEAR the well-managed home vegetable garden will contribute more to family living than at any other time during the last three decades. An estimated 40 to 45 million families are expected to plant gardens in 1975, or about 20 percent more than in 1974.

On the basis of current values, the average urban home garden can produce more than $150 worth of fresh and processed vegetables. People living in high-price areas can easily grow twice this amount. Country dwellers may harvest produce worth $700 or more from gardens of a quarter acre or less.

A garden can also give you a greater variety of fresh vegetables than you may find on the market; it gives you a chance to exercise; and it can be a pleasurable hobby.

Home gardening does not require a large outlay for tools. All you need to start with is a good spade, hoe, rake, stakes, and string. As the garden season progresses, a good duster or sprayer is important for insect and disease control.

Where to garden?

If you don't have a suitable garden area at home, you may be able to rent a plot in a community garden sponsored by a park district, some other civic group, or a farmer. Community gardens are generally fertilized, plowed and tilled, and ready for planting.

Often several families can join together and rent a vacant neighborhood lot. Some people with limited space successfully grow vegetables in containers on patios or along sidewalks.

Even if you don't plant and grow a garden, you can harvest your own fresh fruits and vegetables at "pick-your-own" farms.

Sun, soil, and water

Sunlight is one of the most important requirements for a successful garden. Continued shade from a building or tall tree will almost certainly doom a garden to failure. The garden should be located no closer to a tree than the tree is tall.

If a partially shaded area is unavoidable, be sure that the shade is only for short periods. In general, leafy and salad vegetables will grow better than most other vegetables in partial shade.

Good soil is important. Poor soils can be made more productive by adding organic matter such as peat moss, rotted manure, or compost. With ample organic matter, the soil can hold moisture, is easy to work, and drains well.

Fertility can be increased with fertilizer addition. County Extension advisers provide assistance with soil tests and recommendations on the kind and amount of fertilizer to use. A good fertilizer maintenance program is to apply 10-10-10 fertilizer at the rate of 15 pounds per 1,000 square feet a year. If you're starting a garden where soil fertility has not been built up over the years, you may get superior results by applying 5-20-20 fertilizer at the rate of 45 pounds per 1,000 square feet. This initial increased amount supplies the extra phosphorus and potash needed for growth and development of the vegetable plants.

J. S. Vondemark is professor of horticulture and H. J. Hopen is associate professor of vegetoble crops, Urbano-Chompaign. J. W. Courter is associate professor of horticulture, Dixon Springs Agricultural Center.

For best growth, vegetables require 1 inch of water per week. When there is less than an inch of natural rainfall, irrigation is desirable. Vegetables should be watered no more than once a week.

Preparing the soil

Your seedbed should be worked until it is free of large clods. But do not rush the season either in preparing the soil or in planting seeds and transplants. If soils are not warmed when you plant, the result will be poor germination, slow growth, and wasted effort.

Proper soil moisture is also important when you prepare your garden. You should be able to take a handful of soil, squeeze it into a ball, and crumble it with your thumb. If it does not form a ball, it is dry. If it looks wet and shiny and breaks into clumps instead of crumbling, it is too wet. Wet soils will ultimately puddle and become very hard. When soils are wet, one should stay out of the garden to avoid compacting the soil.

Raised beds will often improve the quality of the garden. You work from a walkway and stay off the beds themselves, assuring better soil tilth.

Some hints for planting

Always grow varieties with the potential for top quality, yields, and disease resistance. *Illinois Vegetable Garden Guide,* Illinois Extension Circular 1091, recommends many superior varieties for Illinois soil and climatic conditions.

Intercropping is a technique for utilizing garden space efficiently. Fast- and slow-growing vegetables are planted in alternate rows (or even in the same row). For example, lettuce can be planted in one row, tomatoes in the next row, onions next, and then brussels sprouts. The lettuce and onions can be removed in time to make room for the larger, later maturing crops.

Succession planting is a technique of growing one crop, removing it, and then planting another in the same row. One might choose to grow

(*Right*) If you don't have room or time for a regular garden, you might grow a mini-garden along the south side of the house.

(*Below*) Mulched vegetables on a research-demonstration plot at Dixon Springs. There will be several demonstration gardens at University fields and experiment stations in 1975. Your Extension adviser can tell you the location of the one closest to you.

The zucchini squash aristocrat is one of many vegetable varieties available to the home gardener in Illinois.

radishes, green beans, and turnips successively in one location, tripling the use of that area.

Caging and trellising keep plants off the ground, thus helping to eliminate many rots and diseases as well as using space efficiently.

Pest control

Once you have planted your garden, you can't just sit back and relax. There will be problems such as troublesome weeds, diseases, and insects. Vegetables simply do not compete very well with any of these. Weeds take away space, fertilizer, and water and act as pest hosts. Diseases and insects may reduce the leaf surface, weaken the plant, or even directly affect the prized fruit.

Most home gardeners find that the Santa Claus method — "Hoe! Hoe! Hoe!" — is the best way to control weeds. A mulch, such as grass clippings, straw, peat, or black Kraft paper, keeps down weeds and also conserves soil moisture. Organic and light-colored mulches keep the soil cool in summer while black polyethylene warms the soil in early spring.

To control disease, grow resistant varieties if possible. Remove weeds and diseased plants to eliminate sources of trouble. Also, rotate your crops if you have room — at least, grow a given crop in a different spot from one year to the next.

Never cultivate, work the garden, or harvest when plants are wet, as dampness hastens the spread of disease by tools and even by your clothes as they brush the plants.

Many diseases and insects can be successfully controlled with garden fungicides and insecticides, applied as dusts or sprays. Always follow the directions on the package. If in doubt, consult your county Extension adviser.

Many people handpick certain insects, particularly the tomato worm. This worm is not dangerous to humans, but it can do a tremendous amount of damage to tomatoes.

Keep up the good work

A good mental attitude — thinking of one's labor as exercise and fun — is important in gardening. This attitude should be maintained through the entire season, not just at planting time. Many vegetable plantings fail for lack of a proper follow-through on combating weeds, insects, and diseases. Some gardeners fail to harvest at the right time or to fully utilize garden products, especially for freezing, canning, and preserving.

When planting your garden, remember that, for months ahead, it can not only benefit you economically, but can be a source of enjoyment, exercise, and good eating.

Heat Unit Systems in Corn Production

C. Y. ARNOLD

Several heat unit systems are being used by the Illinois field corn and sweet corn industries for determining the adaptability of hybrids to particular locations, timing of successive plantings, and predicting harvest dates.

These systems give varying degrees of accuracy, depending on the relationship that is assumed between temperature and rate of plant development. To know which system is most reliable, it is necessary to determine which of the assumed temperature-rate relationships comes closest to reality.

Temperature-rate relationships for three of these systems are shown in Figure 1. System A assumes that, above a specified base temperature (50° F.), the rate increases in a linear fashion over the range of temperatures encountered. System B is a base-temperature:cutoff-temperature (BT:CT) system developed by Barger. It assumes that the rate increases in a linear fashion from 50° to 86° F., and then levels off. System C is a BT:CT system developed by Gilmore and Rogers. It assumes a linear increase up to 86° F. and a linear decrease above this temperature.

These three systems are attractive to users for several reasons: They are easy to understand; they can all be effectively used with daily maximum and minimum temperatures; and the calculations are simple. In system A, degree days per day may be calculated by this formula:

$$\frac{\text{Daily max.} + \text{daily min.}}{2} - \text{base temperature}$$

In system B the same formula is used except that, before the calculations are made, the BT is substituted for the minimum if the minimum is lower than the BT; and CT is substituted for the maximum if the maximum is higher than the CT. In system C the BT is again substituted for the minimum if the minimum is lower than the BT. The calculations are made and then, if the maximum is higher than CT, the difference between the two is subtracted from the result.

C. Y. Arnold is professor of vegetable crops, Department of Horticulture.

Problems examined

In the Spring, 1971, issue of Illinois Research, the author speculated on the accuracy of the BT:CT system developed by Barger. Since then, we have made extensive analyses, involving 62 plantings of Golden Cross Bantam sweet corn.

The primary problem in studying a BT:CT system is to find the combination of BT and CT that gives the least error. In the past, the approach has been to make an educated guess as to what the combination ought to be and check a few combinations in that range. We took a broader approach. We developed a computer program that enabled us to check 116 combinations at 5° intervals. Some extended beyond a range of temperatures that we thought reasonable. A partial description of the results in the period from planting to harvest (P-H) is in Figure 2. The coefficient of variation (cv) in degree days is used as a measure of the error for each combination. The lower the cv, the less the error.

Let us look first at the cv values with a CT of 105°. Note that the values are the same in the Barger and the Gilmore-Rogers systems. The reason is simple: The two systems vary only in the way they modify the temperature-rate relationship above the CT. In this case we set the CT so high that there were no temperatures to cut off. Each system then becomes the linear system A in Figure 1. In this system, the error decreases from a cv of 10.7 at a BT of 60° to 4.1 at a BT of 30°.

When the CT is lowered into a range where it significantly modifies the results, the situation changes. The BT giving the best result varies with the CT. Also, the best BT for a particular CT is different in the two systems. The combinations giving the best results were 45:80° for the Barger system (B in Figure 1), with a cv of 3.3; and 50:85° for the Gilmore and Rogers system (C in Figure 1), with a cv of 3.4.

Historically Gilmore and Rogers introduced their system first, and proposed a combination of 50:86°. Barger changed the method of calculation and thus, the temperature-rate relationship; but he proposed the same BT:CT combination. As shown in Figure 2, the cv for a 50:85 combination in the Barger system is about 4.3. Apparently, when the method of calculation was changed, the BT:CT combination should also have been changed.

Another aspect of the problem is related to the temperature frequency distribution over the growing season. The distribution found over 14 seasons is as follows:

Temperature, degrees F.	*Pct. of daily mean temperatures, planting to harvest*
40 to 50	1
50 to 60	2
60 to 70	24
70 to 80	57
80 to 90	15
90 to 100	1

Note that 96 percent of the mean daily temperatures were between 60° and 90°, and that 57 percent were in the narrower range from 70° to 80°. It is imperative that a heat-unit system be most accurate in the range of most frequent temperatures, if errors are to be minimized.

In the past, too much emphasis has been placed on accuracy in the lower temperature range. For example, the base temperature has been assumed to be about 50°. But when

we used linear system A (CT 105° in Figure 2), the cv at a BT of 50° was 6.5. By switching to a BT of 30°, we reduced the cv to 4.1. Accuracy in the lower range, where temperatures occur less frequently, had been sacrificed for accuracy in the range where they occur more frequently, with a net increase in overall accuracy.

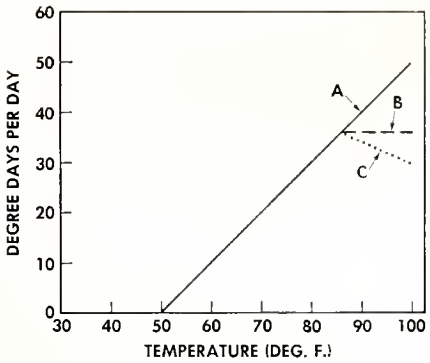
The introduction of an effective CT in systems B and C is meant to bring the temperature-rate relationship closer to its true value in the high temperature range. Note that when this is done the appropriate BT falls closer to the expected 50°.

Although all three systems can be adjusted to give a reasonable level of accuracy, BT:CT systems are more accurate than the linear system in the low and high temperature ranges. They also achieve higher acceptability because the values for BT and CT are more in line with what the user thinks they should be.

This leads to another point. Calculated values for BT and CT are determined, in part, by the temperature frequency distribution in the study. These values may be less accurate when the system is used in a season or an area with a significantly different temperature frequency distribution. We hope, however, that the temperature coverage was wide enough to make the results acceptable over most of the corn-growing areas.

How accurate?

The error is put in a more practical perspective if it is measured in days (2 × the standard deviation) rather than in degree days. This measurement says that 95 percent of the time the actual harvest date will fall within a certain number of days before or after the predicted harvest date. For example, in the 62 plantings the actual time from planting to harvest varied from 64 to 93 days. The average was 74 days. When we predicted that harvest would be 74 days after planting, the actual harvest date was within plus or minus (±) 12.3 days of the predicted date 95 percent of the time. This approach ignored a correction for variations associated with temperature, and would be roughly equivalent to the use of "days to harvest" in a seed catalog.



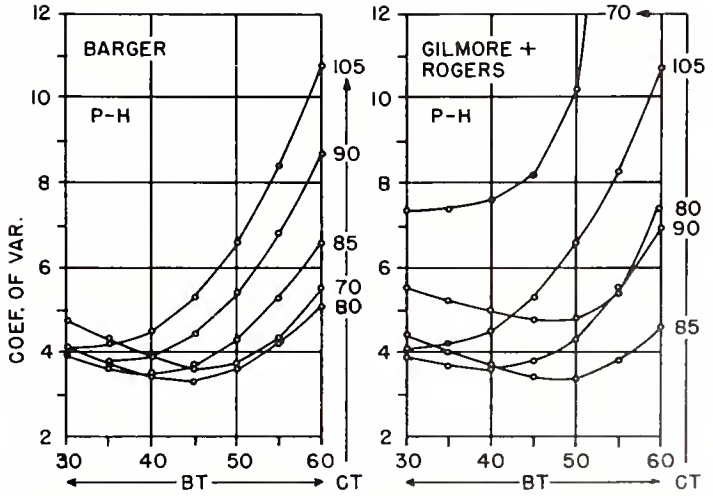
Temperature-rate curves for a linear (A) and two base-temperature:cutoff-temperature heat unit systems (B and C). (Fig. 1)

When we used the linear system A with a 50° BT as a basis for prediction, the error was reduced to only ± 10 days. With a 30° BT, the error was ± 6.0 days. It was further reduced to ± 5.0 days if we used the Barger BT:CT system with a 45:80° combination or the Gilmore-Rogers system with a 50:85° combination. So, with the appropriate BT and CT, the error was reduced to about 41 percent of that found when the effect of temperature was ignored.

Processors of sweet corn use a supplementary observation to improve the accuracy of harvest predictions: They check the silking date. This minimizes the errors resulting from an imperfect heat unit system, and the effect of other factors such as day length or moisture stress on the rate of development up to this point. In our study the number of days from silk to harvest varied from 14 to 25, and averaged 18. When the average was used as a basis for predicting the days from silk to harvest the error was ± 5.2 days. Using linear system A with a BT of 35°, the Barger system with a 45:80° combination, or the Gilmore and Rogers system with a 50:85° combination, the error was reduced to about ± 2.5 days. So, by combining the observation of silking dates with the use of heat units, the error in the prediction of harvest dates was reduced to 20 percent of the error when these factors were ignored.

Barger system recommended

In summary, both BT:CT systems described here give results as good as, or better than, those obtained with the linear system. Since they are closer approximations of the average temperature-rate relationship from planting to harvest, they will probably give more consistent results over a wider area. Because of the simpler method of calculation, the author recommends the Barger system, but with a 45:80° combination rather than the 50:86° originally proposed.



Error pattern from combinations of base temperatures (BT) and cutoff temperatures from planting to harvest (P-H). (Fig. 2)

Reports From Sinnissippi Forest

A Cooperative Enterprise Combining Business, Research, and Education

LOCATED along the Rock River about three miles from Oregon, Illinois, Sinnissippi Forest is a memorial to one man's faith in farm forestry. This man was Frank O. Lowden, Governor of Illinois from 1917 to 1921, and twice a candidate for the Republican nomination for the presidency.

Mr. Lowden began acquiring the land in 1899, with a purchase of 500 acres. Through the years he added to the property until it totaled 4,500 acres when he died in 1943. Of this, a little more than half was forest land. The Indian name for the Rock River, "Sinnissippi," was given to the area by Mrs. Lowden.

Mr. Lowden's interest in land and its place in the economy was reflected in the management of Sinnissippi. Land suitable for crops was farmed according to the best scientific data available at the time. Forest land was protected from fire and grazing. Open areas within the forest land were reforested, generally in pine, but always with an interest in getting the right species of tree on the right soil.

In 1939 Mr. Lowden and J. N. Spaeth, then head of the University of Illinois Department of Forestry, initiated a long-time cooperative research program. The agreement continues to be honored by the University and by Mr. Lowden's two daughters, Mrs. Albert F. Madlener, Jr., and Mrs. C. Phillip Miller (and her two sons, Warren and Phillip).

One of the studies conducted under the agreement concerned the durability of fence posts. The U.S. Forest Products Laboratory also cooperated in this work. Begun in 1943, the study lasted for 25 years. During this time the durability of various woods and the effects of chemical treatments on post service life were reported to Illinois farmers and their counterparts throughout the world.

In 1942 the University and the Sinnissippi owners cooperated in building a sawmill to process the logs produced by improvement cuts and by harvesting and thinning studies. The mill now sells about 250,000 board feet of lumber that goes into farm buildings, fencing, furniture, flooring, and crating. In addition, some of the lumber is converted into fencing, pallets, and miscellaneous products on the farm.

The University has also conducted a species adaptation study on the property. The study included not only native species, but also species from all parts of the world having a climate similar to that of Illinois. Seed of each species was collected from a number of locations within the natural range of the tree and the progeny was studied. The growth of the hardwood stands was systematically measured to determine yield and to learn how species and timber types were related to site conditions.

Another project has been growing Christmas trees. Beautiful pine, spruce, and fir trees and boughs are now marketed as far away as 200 miles.

Sinnissippi Forest is not only a successful business and research enterprise but also an instrument of instruction for the public. Every year the area attracts thousands of visitors who come to observe the conservation practices in use, to study the vegetation of the area, or simply to enjoy its beauty. — *C. S. Walters, professor of wood technology and utilization*

Estimating the Value Of the Outdoor Education

FOR MANY YEARS Sinnissippi Forest has been used as an outdoors classroom. Until 1967 guided tours were conducted, but, as the number of visitors increased year by year, the demand on the forest manager's time became too great.

A self-guiding nature trail, established in 1968, now permits school classes and adult groups to visit the forest on their own. The trail, 1¼ miles long, has 24 marked points, which are described in a booklet prepared for the visitors. This nature-education service is free to the public.

In 1973, a representative year, 4,709 children and adults took the self-guided walk. Special tours were conducted for an additional 356 visitors. Not included in these figures are the 1,674 Boy Scouts, with 273 leaders, who also used the forest.

With increasing pressure on forest land for alternative uses and with the need to allocate investment resources wisely, it becomes more and more important to determine the entire value of a forest property. The value of nonmarket benefits has to be estimated, as well as the commer-

Visitors to Sinnissippi Forest, 1973

Origin	Average distance (miles)	Number of visitors		Visitor miles		
		Students	Adults	Students	Adults	Total
Oregon	5	508	158	5,080	1,580	6,660
Vicinity of Oregon	10	296	50	5,920	1,000	6,920
Other Ogle County	15	293	124	8,790	3,720	12,510
Rochelle	20	330	33	13,200	1,320	14,520
Dixon	15	98	14	2,940	420	3,360
DeKalb	40	272	46	21,760	3,680	25,440
Rockford	25	1,976	220	98,800	11,000	109,800
Chicago and suburbs	100	166	116	33,200	23,200	56,400
Urbana-Champaign	180		32		11,520	11,520
Other	50	207	126	20,700	12,600	33,300
Total		4,146	919	210,390	70,040	280,430

cial value of timber. Accordingly, we have estimated the value of the outdoor education use at Sinnissippi.

Our estimate is of the present use value only — not the value of maximum potential use. It utilizes a form of the expenditure method and is based on the assumption that the monetary value of the nature trail is at least as great as the amount that visitors spend to reach the trail. The only costs considered in our study are transportation costs. To consider other costs would be highly speculative, as no additional cost data are available.

The numbers of visitors coming from various places were tabulated, as shown in the table. The average one-way distance from each point of origin (column 2 of the table) was multiplied by two to get total distance traveled. This in turn was multiplied by the number of visitors to determine the number of visitor miles. Visitor miles in 1973 totaled 280,430.

Assuming an average travel cost of 2 cents a mile (equivalent to 80 cents a mile for a bus with 40 passengers), we estimate the total value of the outdoor recreation use at Sinnissippi to be about $5,600. Of this amount, 75 percent was attributed to student visits.

If we assume that every year about the same number of persons use Sinnissippi Forest (the number of visitors per year has been relatively stable since 1970), we can estimate the total capital value of the outdoor-education use. If the value for each year is taken as perpetual annual rent, the total capital value can be calculated as $C = \frac{a}{i}$ where a = annual rent and i = interest rate. At an interest rate of 5 percent and an annual rent of $5,600, the estimated total capital value is $112,000, or about $43 per acre. This figure reflects the monetary value of the present use of Sinnissippi Forest for outdoor education.

The value of the outdoor education use is only part of the total value of the potential non-timber uses of Sinnissippi Forest. These are presently being evaluated as part of a research program to determine the optimal combination of alternative uses for Sinnissippi Forest. — *Dieter R. Pelz, assistant professor of forestry; and Howard W. Fox, assistant professor of forestry and manager of Sinnissippi Forest*

Tornado Destroys Some Of the Pine Plantations

On June 20, 1974, high winds and a tornado whipped through Sinnissippi Forest, uprooting or blowing down trees over more than 30 acres.

Destruction was complete on 11¼ acres of a 70-year-old pine plantation, one of the oldest in Illinois. On an additional 21 acres of pine and natural hardwoods, 20 to 50 percent of the trees were destroyed. The loss amounted to 293,000 board feet of timber valued at over $10,000, of which only about $6,000 was salvageable. The damage to research plots cannot be measured in dollars.

Salvage cuttings were started in August and were nearly completed by November. In some places, we will have to replant by hand, which is expensive and time-consuming. However, we hope that much of the ravaged land will replant itself with seed from the adjacent mature trees. — *Howard W. Fox*

Tenacious Elms Still Live After Girdling

While many pines at Sinnissippi were destroyed by the tornado, some native elms withstood the storm as well as previous efforts to kill them.

It seems incredible that anybody would want to destroy American elms when they are fast disappearing as the result of a shade-tree disease. However, any deciduous trees that invade a pine plantation should be weeded out to favor pine growth.

In 1972 it was decided to eliminate the elms that had invaded a 28-year-old white pine plantation. To accomplish this objective, the elms, which were 6 to 12 inches in diameter, were girdled. Girdling was done in the spring, when the cambium cells were tender and the bark peeled easily.

The conventional method of girdling is to cut the bark with an axe, chopping a fringe of overlapping cuts around the tree's circumference. However, since the elms' bark slipped easily, it was stripped from the girdle to the groundline, a distance of about 3 feet, and was removed completely around the tree.

When the trees were examined in the summer of 1973, they appeared to be as healthy as if they had not been girdled. Their good condition was attributed to an extremely wet summer in 1972, and the fact that the pines had shaded the stems of the peeled elms. The exposed cambium apparently had not dried enough to cause death, and callus tissue had formed to completely cover and protect the girdled areas.

Now, in the spring of 1975, these tenacious elms are still clinging to life. — *Howard W. Fox*

Determining The Optimum Number of Campers per Campground

R. A. YOUNG

In amount of public recreational land per capita, Illinois ranks lowest of all the states. Our total deficit is estimated at 187,000 acres. To make matters worse, almost half of our public recreational land lies in the nine southernmost counties, far removed from the state's population centers.

The energy crisis makes it likely that more Illinoisans will be spending their vacations in their home state. Such a trend seemed to be developing last summer: The state's campgrounds had more campers in 1974 than in 1973, with the vast majority of the campers being Illinois residents.

Obviously, our public recreational lands must be well managed to meet present and future demands. Existing sites must be correctly used and maintained, and new areas should be located on soils that are best suited for the intended use.

Since 1970 the Forestry Department has been conducting a research project to aid in managing recreational areas. The study is concerned with the carrying capacity of an area, or the number of people it is capable of supporting. Since camping is the fastest growing recreational activity on state and federally owned recreational areas, the project is limited to campgrounds.

In studying carrying capacity, we are considering three things: management objectives for the area, attitudes and preferences of the users, and impact on the physical resources.

R. A. Young is a forester, Department of Forestry.

Objectives and attitudes

One cannot determine carrying capacity without knowing the management objectives for a given area. These may be to provide camping in a near-natural setting with a low level of development, or to provide high-density use with well-developed facilities. Obviously, the first kind of campground will have a much lower carrying capacity than the second, even if the two occupy the same type of site.

Associated with this, but I think different, are the visitors' attitudes about the area. One camper, who enjoys visiting with other campers, may consider a campground nearly empty when it is 50-percent occupied. Another camper, who likes to be isolated, may believe that the same campground is too full and may move to another that is nearly empty (if he can find it).

Perhaps more important than the differences among campers are the differences between campers and managers. Usually public campground managers see an area as full or over-used when visitors perceive it as good or not crowded at all.

Two southern Illinois campgrounds included in our study illustrate campers' differences in philosophy. One campground, located in a state park, was highly developed, with camping sites close together and unscreened to allow for camper interaction and socializing. Campers usually stayed only one or two nights before moving on with their travel-oriented equipment. They wanted a conveniently located campground and such amenities as electricity, showers, and a store.

Differing from the state park campers, not in socioeconomic background but in camping style, were the visitors at a national forest campground, where the units were widely spaced with natural screening. These campers chose the campground for the privacy and the activities rather than convenience of location. They tended to stay much longer than the state park campers, and used more tents and tent trailers.

Planners of private and public campgrounds need to know what type of user will or should use an area and plan the facilities accordingly. It is important in providing satisfying recreational experiences that all degrees of campground development be available and that not all campgrounds be developed identically.

Impact on physical resources

For our study of impact on physical resources, we are analyzing the effects of recreational use on several soil and vegetative variables in campgrounds. We wanted to determine the conditions under which these areas did not degenerate faster than they could regenerate themselves or be regenerated artificially.

Most campgrounds in the state were found to be located on either forested loess, fragipan, or claypan soils. For our study, we randomly selected three campgrounds on each of these three soil groups.

At every campground three camping units were randomly selected in each of four levels of camping use: (1) sites used more than two-thirds of the time, (2) sites used less than two-thirds but more than one-third of the time, (3) sites used less than one-third of the time, and (4) control sites not used for camping, but located adjacent to the campground.

Having made various measurements and collected samples at all locations selected for study, we are now analyzing the data. Preliminary results indicate that organic matter, pH, compaction, and nitrogen differ significantly among the soil types studied and among the four levels of camping use.

Out of this part of the study can come recommendations concerning physical carrying capacity for campgrounds on the soil types studied. This information, considered in view of management objectives and users' attitudes, will enable campground managers to more wisely use Illinois's limited recreational land.

Five Staff Members Are Honored

Five College of Agriculture staff members were honored March 7 in the fifth annual Paul A. Funk Recognition Program. Under this program, cash awards are provided by the Paul A. Funk Foundation of Bloomington "to recognize outstanding performance and high achievement among the faculty of the College of Agriculture at the University of Illinois."

The award winners are listed below, along with brief summaries of their major achievements.

George Richard Carlisle

Professor Carlisle's leadership in improving pork quality has won him nationwide recognition.

Largely with his guidance and help, the "Probe and Weigh Program" has been established for swine producers; eight producer-owned swine test stations have been established in the state; and live hog evaluation and carcass demonstrations have been initiated in most Illinois counties. Professor Carlisle deserves much of the credit for popularizing the Illinois fortified corn-soy ration, which has been adopted by most midwestern pork producers. And he was instrumental in the development of confinement swine production in Illinois.

Professor Carlisle also had major responsibility for developing interdisciplinary Extension programs to attack the problems of modern swine production.

Because of his expertise, his advice is widely sought by all segments of the swine industry.

Walter O'Daniel Scott

Dr. Scott is a world authority on seed certification. He has been president of the Association of Official Seed Certifying Agencies, and has served on many committees of this national organization. He helped to unify seed certification rules among the states, and to formulate laws protecting plant breeders' rights. On two occasions he was invited to India for advice on seed programs.

For many years he served on the board of directors of the Illinois Crop Improvement Association and helped to develop information programs for the seed industry, including five regional seed clinics each fall and an annual Seedsmen's Day.

Dr. Scott has advocated a total educational program in agronomy extension, including information on soils, plant breeding, pest control, and crop management. His widely used book on soybean production exemplifies his skill in translating research results into usable information.

Malcolm C. Shurtleff

Dr. Shurtleff is one of the nation's outstanding plant pathologists. He is highly esteemed for his classroom teaching and research, as well as his extension activities.

In 1970 he and an associate were the first scientists to publicize a new virulent strain of southern corn leaf blight. For their efforts in informing farmers about the disease and in identifying resistant corn varieties, they were commended by an Illinois State Senate Resolution.

Dr. Shurtleff's professional capabilities were further recognized when he became the first active extension specialist in the nation to be elected a Fellow of the American Phytopathological Society.

He has produced an unparalleled quantity of publications, color slide sets, and other materials which are used nationwide in extension work and classroom teaching. And through his research he continues to help expand man's basic knowledge of plant disease.

Lawrence Harry Simerl

An unusual skill in clarifying complex economic issues distinguishes Professor Simerl's extension program in agricultural economics.

The basic tool in his program is a weekly outlook letter, which reaches 16,000 leading reporters, farmers, landowners, agribusiness personnel, educators, and government officials in 49 states and 16 foreign counties. Major economic developments, policies, and issues are regularly covered, as are analyses of the crop and livestock-poultry outlook; the sources and reliability of market information; and other topics.

His program also includes two annual publications, special articles, speaking engagements, radio and television appearances, and numerous private consultations. (His column, "Farm Business Trends," regularly appears in Illinois Research.)

As the result of his many effective extension activities, Professor Simerl has become one of our most respected and best known faculty members.

Joseph Tobias

Dr. Tobias is honored for his significant contributions to the dairy industry.

His research on the technology and bacteriology of high-temperature, short-time, continuous-flow systems of pasteurizing ice cream mix helped to set a new trend in the manufacture of ice cream. The continuous process increased the rate of production while reducing energy consumption; and the high temperatures improved ice cream body characteristics.

Dr. Tobias's excellence as a teacher was recognized by Alpha Zeta in 1963, by the Student Affiliate Division of the American Dairy Science Association in 1970, and by the American Dairy Science Association in 1971. The judging teams that he has trained in organoleptic evaluation of dairy products have unsurpassed records in national competition.

He has extensively shared his technical expertise not only with this country, but also in Indonesia, where he served as an adviser in 1973.

FARM BUSINESS TRENDS

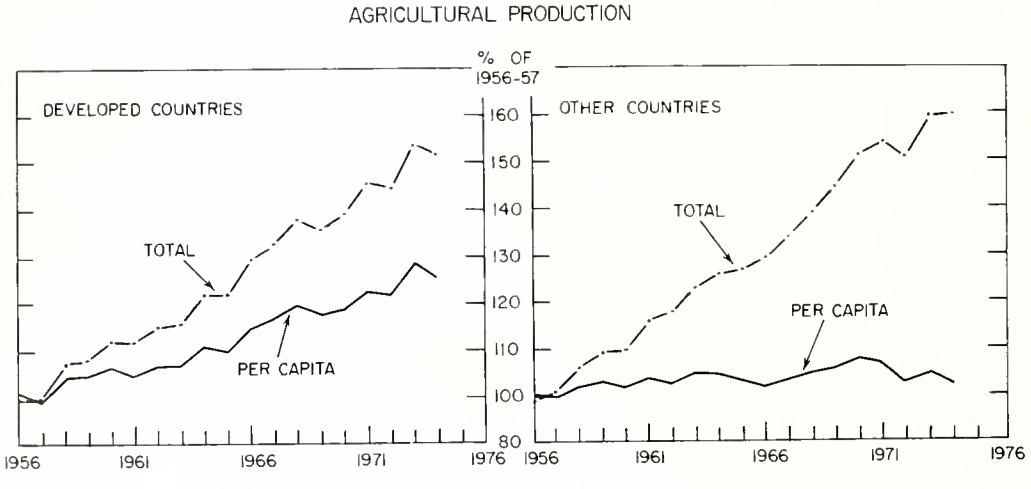
THE EARTH'S FARMERS have been increasing production at an unprecedented rate, but the demand for food has increased even faster. The results are rising prices and increasing hunger.

Agricultural output in the well-fed countries increased more than 50 percent during the past 20 years. Population growth was only about half that amount, so the production per person gained about 25 percent. The well-fed people include those of the developed countries such as the United States, Canada, Japan, Australia, and the nations of Western Europe. The people of these countries do not eat more pounds of food than they did 20 years ago. Rather, much of the increased output of crops has been used to improve their diets by providing more meat, milk, and eggs.

Agricultural output by the less developed countries increased even more — about 60 percent. But their populations increased about as much as food production. Hence, their production of food per capita gained very little. In fact, it has decreased since 1970.

Looking ahead, world food experts see world population increasing more during the next decade than during the past 10 years. The most rapid growth rates will be in the already over-populated countries. This is inevitable because of the record-large number of girls entering the child-bearing ages in those places. There is no prospect for any adequate planned population control in these nations in the foreseeable future. In contrast, world food production may increase slower than during recent years. Most of the good land has already been brought into cultivation, and costs of fertilizers and other essential inputs are rising rapidly. Furthermore, in many lands economic and political conditions are not favorable for rapid increases in agricultural production.

The United States will continue to be the world's principal exporter of agricultural products. As in the past, most of these products will be sold to the developed countries. Shipments to the less developed nations will depend on (1) their buying power, (2) the willingness and ability of the governments to receive and distribute food to their needy people, and (3) the inclination of our citizens to tax themselves so that food can be taken from our markets and shipped to hungry nations. — *L. H. Simerl*



Agricultural production of the developed, well-fed nations increased about 50 percent during the past 18 years; but output increased even more, 60 percent, in the less developed nations. Population growth, however, was only about half as fast in the developed countries as in the other countries. Agricultural output per capita increased about 25 percent in the developed nations, but gained very little in the other nations.

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSU

Baled hay at Dixon Spri Agricultural Center. For years research and dem strations at DSAC h been directed toward solution of Southern Illi problems (page 3).

COLLEGE OF AGRICULTURE Volume 17, Number 3

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

Summer, 1975 Volume 17, Number 3

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The Illinois Agricultural Experiment Station provides equal opportunities in programs and employment.

THIS YEAR marks the centennial observance of the establishment of the first agricultural experiment station in our nation: the founding of the Connecticut station in 1875. The observance is an appropriate occasion to reflect on the impact of those first 100 years of agricultural research.

I view man's entire existence on earth as a learning process. And in the beginning, I suspect, the process was extremely slow. I like to think of our modern agricultural research — largely directed toward food production and building toward a better life — as a continuing proposition of compacting human experiences.

For example, given unlimited time, I suspect man would have discovered the potential of soybeans and have learned that they grow productively in Illinois as well as in China. But through deliberate investment in a research system, man has made such developments come about more quickly.

I'm confident that the agricultural experiment station concept, which has resulted in a century of learning about food production, has contributed much to the success of our nation. It seems apparent that the future of the world, and solutions to the problems of feeding people everywhere, will largely depend upon the willingness of people to invest in research on such problems.

We must think about preservation of mankind beyond the limits of our own lifetimes. We must develop a concept of a "forever trajectory" of mankind on earth. His survival will depend upon how well he acquires information necessary to live with himself on earth.

And so it is that I view this centennial celebration of agricultural experiment stations as "the first 100 years of forever." In fact, that is the theme we hope to establish in Illinois through a variety of releases and presentations through the mass media.

Look for centennial articles in this and future issues of ILLINOIS RESEARCH. They'll be identified by our theme and by the centennial symbol above. — *G. W. Salisbury.*

Cattle roundup at DSAC.

Dixon Springs Agricultural Center: *Why and How It Came Into Being*

PAUL W. REXROAT

SOUTHERN ILLINOIS in the early 1930's was experiencing serious economic and social problems which had existed long before the Great Depression. In response to some of these problems, the University of Illinois College of Agriculture, cooperating with federal and state agencies, established Dixon Springs Agricultural Center (DSAC) in the mid-1930's. It is located near Robbs and Simpson in Pope County.

The geology of Southern Illinois, the pattern of early settlement, and the use of inadequate farming methods all contributed to the area's problems. As economic and social conditions in the area continued to deteriorate, the need for change became evident. Finally, national political forces produced federal programs which made land, money, and labor available for the creation of DSAC.

Geology and early history

The present topography of Southern Illinois is the result both of land movements that folded rock strata millions of years ago and of subsequent glaciation. Illinois has been almost wholly covered by four great glaciers. The last glacier receded about 12,000 years ago. It left behind various materials, including a rich soil parent material called loess. Unfortunately, only a thin layer of loess was deposited on Southern Illinois. The land movement and glaciers left the area with a large percentage of soils highly subject to erosion and unfit for crop production.

Archeological evidence indicates primitive men were definitely in Southern Illinois around 8000 B.C. About 3000 B.C., Indians in this area did some of the continent's first farming. By 500 B.C., thousands of Indians had settled in villages in Southern Illinois and were growing large quantities of corn, beans, and squash.

The first white men to traverse what is now Illinois were Father Jacques Marquette, a Jesuit priest, and Louis Joliet in 1673. La Salle and Tonti made voyages through the state in 1679 and 1681 and claimed the Mississippi Valley for France. After the end of the French and Indian War in 1763, France ceded to Great Britain all Canada and all claims east of the Mississippi thus assuring the Illinois region would be settled by English-speaking people.

During the American Revolution, the Illinois region was taken from the British by one brave American officer, George Rogers Clark, who never had more than 200 men at his command. Clark and his men landed in Illinois at Fort Massac in 1778 and marched across Southern Illinois to Kaskaskia, capturing it without a fight. He then secured the entire area east of the Mississippi and held it until the Treaty of Paris in 1783 formally recognized American control of this region. Illinois became a territory in 1809 and a state in 1818.

19th century settlers

The original settlers in Southern Illinois were French. Even in 1800, French-speaking people made up half of Illinois's 2,500 white inhabitants. Thereafter the population grew rapidly, reaching 35,000 in 1818. Most of the new arrivals came from North Carolina, Tennessee, Virginia, Kentucky, Maryland, Pennsylvania, and New York.

The need for nature's resources determined to a great extent the pattern of land settlement. The major resource needed by farmers on unimproved land was timber to construct a home, farm buildings, and fence rails. Thus, early farmers ignored the prairies and settled on timbered uplands.

Each man had to build his own buildings, make his own furniture, tan his own leather, break his own land, and hunt and butcher his own food. Each woman had to preserve foods and manufacture clothing, bedding, soap, and dyes from the raw materials found or produced on her own farm.

Paul W. Rexroat is a former publications editor, College of Agriculture.

The typical farm family arriving in Southern Illinois in the late 1700's or early 1800's had only the bare essentials: some tools, a gun, iron kitchen utensils, a spinning wheel, a loom, and some clothing and blankets. They also had seeds for the crops that would produce food and raw materials for clothing.

Life for Southern Illinois settlers in the early and middle 1800's was not very romantic. People would occasionally get together for a corn-husking, logrolling, cabin-raising, wedding, legal hearing, or militia meeting. But otherwise life could be lonely.

A continuing decline

As the nineteenth century ended and the twentieth began, Southern Illinois began lagging behind the rest of the state in a number of ways. Many Southern Illinois farmers failed to adopt better farming practices as they were discovered in the late 1890's and early 1900's. Why this happened is difficult to determine. Perhaps they lacked the capital needed for farming changes, or perhaps they distrusted "book farming."

Corn yields for Pope County, where DSAC is located, reflect the decline in the area's productivity. Before 1890, Pope County yields did not differ much from state average yields. For instance, from 1876 through 1886 the average yield of corn in Pope County was 26.2 bushels per acre, compared with 28.8 bushels for the state. In the 11 years from 1926 through 1936, Pope County had average corn yields of 21.1 bushels per acre; the state, 32.6 bushels. The Pope County average from 1937 through 1944 was 27.6 bushels, while the state average jumped to 48.6 bushels.

Average gross income per farm in 1929 in Pope County was $820; 45 percent of all farm families had an average gross income below $600. The state average farm family income for 1929 was $2,467. According to a survey in 1935, about 80 percent of Pope County farm families were cultivating 80 acres or less.

About 62 percent of the family heads surveyed in Pope County in 1935 were employed in agriculture, compared with the state average of 11 percent. The largest employment category in Illinois in 1935, manufacturing occupations, was scarcely represented in Pope County.

Only about a third of the homes studied in 1935 were in good condition; more than half needed major repairs; and at least 15 percent were beyond repair. Two-thirds of the families studied had no well, using only cisterns even for drinking water.

Federal land programs and DSAC

It became evident during the Great Depression that too many people were trapped trying to earn a living by farming marginal agricultural lands. These unfortunate people were slowly but surely falling further behind the great mass of American people, while at the same time destroying lands which never should have been farmed.

Thus, it was a basic belief of New Deal officials that the cultivation of poor lands threatened the national economy and was inconsistent with sound conservation policy. The Federal Resettlement Administration was created on May 1, 1935, to unite under one administration the assortment of land program and resettlement activities inherited from several other agencies. One of these activities was the establishment of the Shawnee National Forest.

Throughout the late 1920's and early 1930's the College of Agriculture had been seeking the means to establish an agricultural experiment station in Southern Illinois. The establishment of the Shawnee National Forest was the opportunity the College had been seeking. Dean H. W. Mumford appointed a committee headed by Professor H. P. Rusk, then head of the Animal Husbandry Department, to see if the College might arrange to use some of the forest land as an experiment station.

An extensive series of discussions followed involving the College and representatives of various federal and state agencies. On August 22, 1933, Professor Rusk sent a tentative proposal concerning the establishment of an experiment station to Henry A. Wallace, Secretary of Agriculture. The College's proposal was so unique it immediately caught the fancy of administrators in all concerned agencies. The basic purpose of the station would be to show what could be done to reduce erosion and control run-off in a relatively short time and at a minmum cost on poor, rolling land which had recently been in cultivation. The proposal was approved and 5,090 acres allocated to what was then called the Dixon Springs Experiment Station.

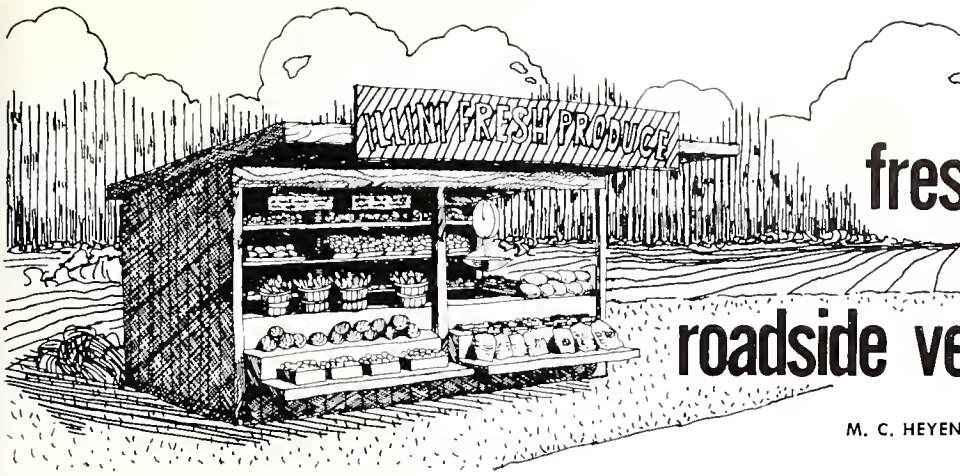
Expanding work

Since the dedication ceremonies on October 8, 1938, the work of DSAC has expanded from erosion control and livestock management to most areas of concern to Southern Illinois farmers. These include pasture management, soil management, forestry, corn and soybeans, vegetables and fruits, insect and weed control, swine, sheep, beef, and herd health.

Some of the most important recent work has involved the use of minimum tillage in the production of corn and soybeans. Researchers using these methods have produced soybean yields of 35 to 45 bushels per acre and corn yields as high as 200 bushels per acre.

DSAC is now used on a University-wide basis. Research has been conducted by the College of Veterinary Medicine, the Department of Geography, the Department of Ecology, Ethology, and Evolution, and the State Natural History Survey. Cooperative research has been undertaken with Southern Illinois University.

Even with a broadened research base, DSAC maintains its original goal of investigating Southern Illinois problems.



freshness attracts customers to roadside vegetable stands

M. C. HEYEN, W. F. WHITESIDE, and J. S. VANDEMARK

"We want it fresh," report customers of roadside vegetable stands. This message came through loud and clear in response to a survey conducted in July and August, 1974. The 705 consumers who responded to the survey all lived in the greater Chicago metropolitan area.

Freshness came out a solid first when customers were asked to rank their reasons for shopping at roadside stands. Flavor and quality ranked second and third, though considerably below freshness. The close relationship among these three factors is well known.

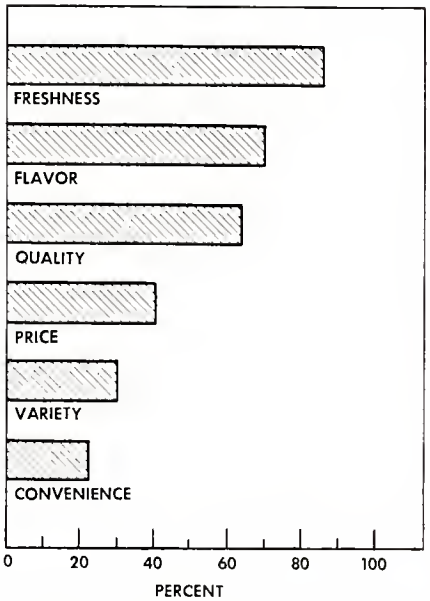
Price ranked fourth, variety of choice fifth, and convenience last. While only 23 percent of those surveyed found it convenient to shop at roadside markets, they all continued to make the extra stop in addition to their normal food shopping.

Consumers verified their desire for a fresh product by their responses to three other questions: (1) Three-fourths of all purchases totaled less than 5 dollars. (2) Nearly all (98 percent) of the consumers said that their purchases were for immediate use by their family and guests. (3) In season, they were likely to visit roadside stands at least twice a week.

Three out of four roadside stand patrons live within 5 miles of the stand, according to this survey. The other 25 percent include many city consumers who drive to the suburban farming areas for the opportunity to buy fresh produce.

It is a good bet that a consumer will buy sweet corn or tomatoes or both on each visit. Sweet corn was the most popular vegetable among those in the survey. Tomatoes, the number one vegetable raised by home gardeners according to a recent Gallup poll, were a close second. Large, red tomatoes were most in demand, with salad (cherry) tomatoes a distant second. Yellow or orange tomatoes were requested by only 6 percent of the customers.

Ranking third in popularity but well behind sweet corn and tomatoes were snap beans, followed by onions and peppers. Fifty percent of all purchases would include these vegetables. According to the Gallup poll, beans, onions, peppers, and cucumbers rank about equal in popularity with gardeners.



Percentages of customers giving various reasons for shopping at roadside stands.

About 30 percent of all purchases included cabbage, potatoes, zucchini squash, or acorn squash. Cherry tomatoes and parsley ranked as the most popular specialty items. Garlic, herbs, shallots, banana peppers, horseradish, and scallop squash add variety and color to the stand displays, but are requested by fewer than one-fourth of the customers. A third of the customers were counting on purchasing Halloween pumpkins come October.

Results of the survey indicate some cultural differences among consumers from different areas. Four roadside stands south and southwest of Chicago reported more requests for greens than did four stands north and west of Chicago. Customers of the four southern stands were also more interested in canning vegetables for future use. This was reflected in a greater number of bulk purchases.

Forty percent of the consumers responding to the questionnaire said they would like the opportunity to pick their own vegetables direct from the field. There could be no better way of being assured a fresh product. Of those interested in picking their own, 40 percent said they would make 10 or more farm visits during the season.

Eighty-two percent reported they had no desire to rent a plot of land on which to grow their own vegetables. They will leave the production of high-quality produce to the experienced vegetable farmer and will patronize his roadside stand.

M. C. Heyen and W. F. Whiteside are Extension advisers in agriculture, Cook County; J. S. Vandemark is professor of horticulture.

Credit Choices of Consumers

As a pilot study, 25 black and 25 white families are interviewed concerning their use of, attitudes toward, and knowledge about four types of credit

VEREE K. ETHRIDGE and MARILYN M. DUNSING

THIRTY or more years ago, Americans tended to postpone their enjoyment of many goods until they had saved enough money to pay for them. But, as we all know, times have changed. Now most Americans are willing to use credit so they can have many of the things they want sooner.

The increasing use of credit, reflecting an increasingly favorable attitude toward it, has been confirmed by research findings. However, little is known about people's use of, knowledge about, and attitudes toward different types of credit. A pilot study was therefore conducted in which this information was obtained from both black and white families for four types of credit; namely, 30-day charge accounts, revolving charge accounts, installment plans, and loans.

The study included 25 black and 25 white families randomly selected in two Champaign subdivisions. They all had similar housing in terms of cost, the original prices of the houses ranging from $15,000 to $18,000. For about 90 percent of the families, mortgages were subsidized by the federal government through Section 235 of the Housing Act of 1968.

All families in the study included both husbands and wives. The men were under retirement age and currently employed. Information was collected from husbands and wives by the interview-questionnaire method, with interviews being conducted by one of the authors.

Veree K. Ethridge is a graduate student and Marilyn M. Dunsing is professor of family and consumer economics.

Family characteristics

Black couples, on the average, were older and had been married longer than the white couples (Table 1). The black families also had more children living at home. Husbands, on the average, had more schooling than the wives, but black wives had slightly more education than their husbands. In general, the blacks had completed fewer years of schooling than the whites.

Of the 50 husbands, 36 (21 black and 15 white) were blue collar workers. The other 14 (10 white and 4 black) were white collar workers. More black wives (40 percent) than white (24 percent) were employed. Of those employed, more black (90 percent) than white (33 percent) had full-time jobs. Median income for all families was in the $7,000-$8,000 range. The black families' median income also fell in this range, but white families' income was in the $8,000-$9,000 range.

Table 1. — Some Characteristics of 25 Black and 25 White Families

Characteristic	Black	White	All
Av. yr. married	11.0	6.5	8.7
Av. age of husband	34.2	26.8	30.5
Av. age of wife	30.6	25.3	28.0
Av. no. of children at home	2.3	1.9	2.1
Av. yr. of schooling			
Husband	11.2	13.2	12.2
Wife	11.4	12.2	11.8

Credit use

In use of the four types of credit, the biggest difference between white and black families was in the whites' greater use of 30-day charge accounts. About twice as many white as black families had such accounts (Table 2). Among those using this type of credit, the average number of accounts was higher for white families (2.4) than for black (1.6). A higher percentage of the white than of the black families charged more than $20 a month on all their 30-day accounts.

Black and white families also differed in their use of revolving charge accounts. Almost 30 percent more black than white families used this type of credit. However, the average number of accounts per family was higher for white (2.3) than for black families (2.1). In addition, a higher percentage of white than of black families charged more than $20 a month and paid more than $10 a month on all their revolving accounts.

About the same number of black as of white families used installment credit and loans. A major household appliance was the most common purchase by both black and white families on their last installment contract.

Of those who had taken out a loan in the last two years, a majority of both black and white families took out only one loan, and their last loan was from a bank. For both black and white families, a car was most often mentioned as the last item purchased through a loan.

Credit knowledge

Husbands and wives were asked to respond "True," or "False," or "Undecided" to the following statements about 30-day accounts, revolving accounts, installment plans, and loans:

You pay no finance charge when you pay your 30-day charge account within the time allowed. More of the white (86 percent) than of the black families (76 percent) knew that this statement is true.

On a revolving charge account monthly bill, you cannot pay more than the payment due. Ninety percent of the white families as compared with 78 percent of the black families, correctly replied that this is a false statement.

An item purchased on the installment plan becomes legally yours when you sign the installment contract. A much higher percentage of the white families (84 percent) than of the black families (58 percent) correctly labeled this statement as false.

A person who has a one-year loan at 24 percent is paying less money in interest than a person who has a three-year loan at 12 percent a year. Many of the families failed to answer this correctly. However, more of the white (64 percent) than of the black families (28 percent) realized that this is a true statement.

Credit attitudes

A second series of statements was designed to obtain the families' attitudes toward different types of credit. Husbands and wives were asked whether they agreed with, disagreed with, or were undecided about each statement.

Black families were inclined to be more wary than white toward 30-day charge accounts, while white were more dubious about revolving accounts. In response to the statement, "Thirty-day charge accounts are too risky for most families," 60 percent of the black families and 48 percent of the white concurred. Conversely, 62 percent of the white and 46 percent of the black families agreed that "Revolving charge accounts cause families to overspend." Since more white than black families used 30-day charge accounts and more blacks than whites used revolving accounts, the differences in their responses to the statements would seem to stem from a difference in experience.

Both black and white families were more favorable toward installment plans than toward revolving accounts. To the statement, "Installment plans cause families to overspend," 42 percent of the white families and only 18 percent of the black families agreed.

A high percentage of both black families (70 percent) and white (84 percent) agreed that families should go to banks to get loans.

Blacks were more inclined than whites to believe that more credit should be available. The statement, "Credit should be easier for low income families to get," elicited a favorable response from 66 percent of the black families as compared with 18 percent of the white. Similarly, 56 percent of the blacks and 20 percent of the whites agreed with the statement, "The government should give more credit to families."

Preference for payment methods

The families were given a list of 13 types of consumer goods and services: food, clothing, jewelry, furniture, television, small appliances, major household appliances, living expenses, medical expenses, vacations, car, gasoline, and education. They were then asked to indicate one or more methods of payment that they considered desirable for each type of goods or service. Their choice was made from six methods: cash, 30-day charge accounts, revolving charge accounts, installment plans, loans from finance companies, and loans from banks. In each family, the husband and wife jointly decided on the best method or methods to be used.

Table 2. — Number of Families Using 4 Types of Credit

Type of credit	Black families	White families	Total
30-day charge	8	15	23
Revolving charge	18	14	32
Installment	18	19	37
Loans	23	24	47

Among black and white families alike, cash was the most frequently checked method of payment for food, clothing, jewelry, small appliances, living expenses, medical expenses, vacations, gasoline, and education. However, for furniture and television sets, both groups checked installment plans more than any other payment method. Blacks and whites also agreed in preferring bank loans to other methods of paying for cars, but the percentage favoring banks was higher for white families than for black.

In paying for major household appliances, black and white families differed as to the preferred method. Installment plans were the most popular method among blacks; cash was most popular among whites.

Some implications

This study revealed differences between black and white families in their use of credit, their attitudes toward it, and their knowledge about it. The families' attitudes and knowledge appeared to be affected by their experience with a particular type of credit.

The false ideas about credit revealed by many of the families indicate a need for more education in this area. Further studies also need to be made to see whether results are the same for a larger sample of the population and also for different socioeconomic groups. Such studies would provide additional information for extension specialists, teachers of adult classes, and social workers as they assist families to use credit more effectively and intelligently.

Twenty-Year Trends in Crop Yields: *Corn, Soybeans, Wheat, and Oats*

J. H. HERBST

Illinois is divided into nine crop reporting districts, with soils, growing conditions, and types of farming being similar within each district. (Fig. 1)

CHANGES in crop yields affect farmers' income, indicate trends in the earning power of land, and help determine the diets of our population and the rest of the world. With a limited supply of land, the acreage suitable for crops will need to be used near its potential if people in the United States and in countries that import our agricultural products are to eat well.

While statements have been made about changes at the state and national level, not too much work has been done on recent changes in areas smaller than a state. To learn more about yield changes within the different sections of Illinois, figures for four crops — corn, soybeans, wheat, and oats — have been tabulated by county and by crop reporting district.

Comparisons between two 5-year periods — 1969-1973 and 1961-1965 — were reported for each county in Economics for Agriculture Letter FM-7 (revised in 1974). An earlier edition made similar comparisons for 1961-1965 and 1955-1959.

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Changes in counties

Corn. Between 1955-'59 and 1961-'65, corn yields per county increased by as little as 6 bushels per acre and by as much as 32 bushels. (The 32-bushel increase was in Christian County.) Increases of 20 or more bushels per acre were noted in 34 counties.

From 1961-'65 to 1969-'73, corn yields again increased, but not as much as in the earlier period. Fourteen counties showed increases of 20 bushels or more per acre, with Moultrie County having the greatest increase (26 bushels).

Wheat and oats. From 1955-'59 to 1961-'65, wheat yields increased by as much as 13 bushels per acre and oat yields, 16 bushels. From 1961-'65 to 1969-'73, 17 counties had increased wheat yields of 7 or more bushels per acre. Oat yields increased by 7 or more bushels in 27 counties, but decreased in 11 counties.

Soybeans. The largest yield increase in a county from 1955-'59 to 1961-'65 was 5 bushels per acre. In six counties, yields decreased by 1 bushel. From 1961-'65 to 1969-'73,

Table 1. — Changes in Corn and Soybean Yields, Selected Periods, 1953-1973, by Crop Reporting District

Crop reporting district	Corn					Soybeans				
	Yield, bu./A.			Percentage increase		Yield, bu./A.			Percentage increase	
	1953-'57	1961-'65	1969-'73	1953-'57 to 1961-'65	1961-'65 to 1969-'73	1953-'57	1961-'65	1969-'73	1953-'57 to 1961-'65	1961-'65 to 1969-'73
Northwest	69.3	85.8	100.3	23.8	16.9	27.4	30.4	35.3	10.9	16.1
Northeast	63.6	81.7	96.3	28.5	17.9	27.0	28.2	32.0	4.4	13.4
West	61.2	83.2	100.8	35.9	21.2	25.9	29.5	34.9	13.9	18.3
Central	65.3	91.3	110.3	39.8	20.9	28.1	31.8	37.4	13.2	17.6
East	63.4	91.0	109.8	43.5	20.7	27.6	30.5	35.8	10.5	17.3
West Southwest	51.8	84.4	99.3	62.9	17.7	23.6	30.1	33.9	27.5	12.6
East Southeast	48.1	80.0	94.1	66.3	17.6	20.9	25.7	29.8	23.0	16.0
Southwest	36.0	57.6	66.8	60.0	16.0	16.1	23.1	26.8	43.5	16.0
Southeast	37.8	63.0	65.5	66.7	4.0	16.7	22.3	24.3	33.5	9.0
State	58.3	83.4	99.0	43.1	18.7	23.8	28.2	32.8	18.5	16.3

however, 12 counties had increases of 7 or more bushels per acre, with two counties, Carroll and Knox, recording 9-bushel increases. An additional 15 counties had increases of 6 bushels.

Crop reporting districts

To provide additional information, percentage changes were compiled for each of the nine crop reporting districts in Illinois (Fig. 1). Within each district, the soils, growing conditions, and types of farming are similar.

Calculating yield changes on a percentage basis may be more important than to say, for example, that corn yields increased 15 bushels and soybean yields 5 bushels during a given period. Percentages can help determine such things as the rate of change in the yield of different crops and, if there are variations, the range in these variations.

The yield data from which the percentages were calculated came from the Illinois Cooperative Crop Reporting Service. Three periods were studied: 1953-1957, 1961-1965, and 1969-1973. Thus, 5-year averages, with 8-year intervals between the median years, could be compared.

In every district, all four crops increased in yield from one period to the next (Tables 1 and 2). However, the rate of increase varied widely with crop, district, and period. For example, oat yields in the Northeast district increased only 0.2 percent from 1961-'65 to 1969-'73, while corn yields in the Southeast district increased 66.7 percent between 1953-'57 and 1961-'65.

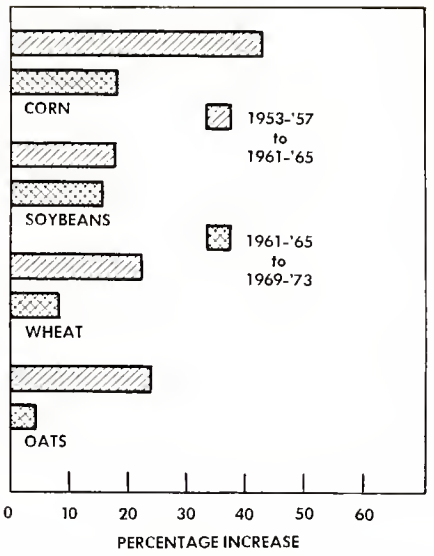
In all districts, corn yields increased more from 1953-'57 to 1961-'65 than from 1961-'65 to 1969-'73. A greater increase in the earlier than in the later period was also shown for oats in all districts, and for wheat in all but one district. In five districts, however, soybean yields increased by a greater percentage in recent than in earlier years.

State trends

Figure 2 shows the yield increases for the state from 1953-'57 to 1961-'65 and from 1961-'65 to 1969-'73. Undoubtedly, the low 1970 corn yields due to southern leaf blight are partly responsible for the smaller increases in the more recent period than in the earlier years.

The data suggest that, for recent years, the soybean-yield increase may not be as unfavorable as commonly thought, at least not for Illinois. Soybean yield increases in the second period were within 2.5 percentage points of corn increases, 8 percentage points above wheat increases, and 12 points above oat increases.

National averages do not show quite the same picture of soybean yield increases. However, a question may be raised as to whether soybean yields are now increasing almost as much as corn yields where soybeans have been grown for a number of years. Testing that idea would involve much study of expanding areas. On the other hand, corn yield increases may be slowing because of the near optimum levels of fertilizer that have been used in recent years.



Increases in the state average yields of four Illinois crops, selected periods, 1955-1973. (Fig. 2)

Illinois wheat and oat yields both increased by more than 20 percent from 1953-'57 to 1961-'65. However, yield increases since then have been quite small. Oats made a specially poor showing, with a 4.4 percent increase from 1961-'65 to 1969-'73. However, oat acreage decreased from 3.1 million acres in 1953 to 1.4 million in 1963, and 0.4 million in 1973. Thus, even though the poor showing of oats is still a matter of concern for farmers who grow this crop, it is not of major importance in the state as a whole.

Table 2. — Changes in Wheat and Oat Yields, Selected Periods, 1953-1973, by Crop Reporting District

Crop reporting district	Wheat					Oats				
	Yield, bu./A.			Percentage increase		Yield, bu./A.			Percentage increase	
	1953-'57	1961-'65	1969-'73	1953-'57 to 1961-'65	1961-'65 to 1969-'73	1953-'57	1961-'65	1969-'73	1953-'57 to 1961-'65	1961-'65 to 1969-'73
Northwest	30.5	36.4	39.1	19.3	7.4	48.0	55.7	57.5	16.0	3.2
Northeast	32.8	38.4	41.5	17.1	8.1	47.3	59.6	59.7	26.0	.2
West	29.4	33.8	36.4	15.0	7.7	41.8	50.1	56.4	19.8	12.6
Central	31.7	38.5	41.3	21.5	7.3	44.7	56.5	59.3	26.4	5.0
East	34.0	39.1	46.4	15.0	18.7	41.5	54.2	58.1	30.5	7.2
West Southwest	31.0	37.2	40.5	20.0	8.9	40.3	48.8	52.2	21.1	7.0
East Southeast	28.2	37.3	39.9	32.3	7.0	36.7	48.2	55.6	31.3	15.4
Southwest	27.9	32.8	37.8	17.6	15.2	33.2	38.9	42.4	17.2	9.0
Southeast	26.6	31.0	35.6	16.5	14.8	31.0	36.5	40.1	17.7	9.9
State	29.6	36.2	39.2	22.3	8.3	44.2	54.8	57.2	24.0	4.4

Livestock Wastes as a Substitute For Commercial Nitrogen Fertilizer

THOMAS STUCKER and STEVEN ERICKSON

The rise in commercial fertilizer prices, a situation intensified by the energy crisis of 1973-1974, has forced many farmers to consider two alternatives. They can reduce fertilizer inputs; or they can substitute relatively less expensive material, such as livestock manure, for the commercial fertilizers now on the market.

In the past four years the average prices paid by Illinois farmers for anhydrous ammonia have increased by 275 percent (Table 1). Although the prices paid for farm products have been increasing also, they have not kept pace with commercial nitrogen prices. The number of pounds of nitrogen that can be purchased with one bushel of corn (corn/N price ratio) has been steadily decreasing.

Table 1. — Nitrogen and Corn Prices and Corn/N Price Ratio

Year	Anhydrous ammonia, $/ton	Corn, $/bu.	Corn/N price ratio
1971	76	1.28	33.7
1972	78	1.18	30.3
1973	88	1.99	45.2
1974	225[a]	2.95	26.2
1975	285[a]	2.75[a]	19.3

[a] Estimated.

Substitute or supplement?

Farmers who already have livestock enterprises may now find it profitable to consider livestock wastes as a substitute source of nitrogen rather than as a supplement to commercial fertilizer. Manure also contains phosphorus and potassium and can be used to improve the structure of the soil.

The amount of nitrogen available from livestock wastes can be increased by using manure more efficiently and by adopting storage methods that will improve nitrogen retention. Nitrogen in this form cannot, of course, be substituted pound for pound for commercial fertilizers, and the nitrogen content of manure will vary according to animal source, waste-handling system, and other factors. Producers should, therefore, be aware of the losses associated with manure handling and storage and have an idea of how much nitrogen is available from manure for the crop enterprise.

Nitrogen losses during storage, treatment, and handling of livestock wastes have been estimated by D. H. Vanderholm as follows: deep pit storage, liquid spreading — 66 percent (maximum); bedded confinement, solid spreading — 34 percent; open lot (with or without shelter), solid spreading, runoff collected and irrigated or spread — 57 percent.

Not all the remaining nitrogen is available to plants the same year the manure is applied. Approximately 50 percent of the organic nitrogen is mineralized (released for plant use) each year. This means half of the nitrogen applied as manure is available the year of application, half of the remaining nitrogen is available the next year, and so forth. Thus, manure provides a nitrogen "carryover" to the succeeding crop.

Value of manure nitrogen

Based on the amount of manure produced in a feedlot or confinement situation, its nitrogen content, losses during handling and storage, and percentage of nitrogen available to crops, the value of manure as a source of nitrogen can be estimated. Table 2 shows the estimated value of nitrogen from swine manure available to plants the year it is applied, both for Illinois and for a hypothetical hog-feeding operation. The total value to Illinois farmers of mechanically collected and distributed (nonpasture) swine manure handled by liquid and bedded solid systems is more than $4 million.

For a hypothetical hog enterprise with annual sales of 1,000 hogs and an annual inventory of about 575 hogs, the value of nitrogen recoverable by plants in the year of manure application is $0.56 per hog sold when the bedded solid waste-handling system is used and $0.29 per

Table 2. — Estimated Swine Manure Nitrogen Production and Value, by Bedded Solid and Liquid Waste-Handling Systems

	Illinois		Sample farm, 1,000 hogs annual sales	
	Bedded solid	Liquid	Bedded solid	Liquid
Aver. annual hog inventory	4,134,000	365,625	575	575
Manure produced, lb./hd./day	9	9	9	9
Nitrogen produced, lb./hd./day	.048	.048	.048	.048
Total N produced, lb./year	69,451,200	6,142,500	9,660	9,660
Lb. of N available to crops 1st yr.	22,918,896	1,044,225	3,188	1,642
Value of 1st yr. N	$3,987,888	$181,695	$555	$286

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hog sold for the liquid waste-handling system. The difference between these two values is due to the greater loss of nitrogen in liquid storage and handling systems.

Table 3 shows the value of nitrogen from cattle manure. The estimates were based on cattle and calves on feed, which in effect excludes most cattle on pasture and assumes that all the manure produced can be collected. The total value of manure from cattle in Illinois from both solid and liquid waste-handling systems is more than $1.5 million annually. On a sample farm with annual sales of 500 head of cattle and an average inventory of about 266 head, the nitrogen value of manure is estimated at $1.88 per head sold for a solid waste-handling system and $1.49 per head sold for the liquid waste-handling alternative. Direct economic comparison of the two waste-handling systems would, of course, depend upon their investment and operating costs, as well as the degree of nitrogen recovery by each.

Table 3. — Estimated Cattle Manure Nitrogen Production and Value, by Solid and Liquid Waste-Handling Systems

	Illinois		Sample farm, 500 head annual sales	
	Solid	Liquid	Solid	Liquid
Aver. annual cattle inventory	421,568	10,752	266	266
Manure produced, lb./hd./day	48	48	48	48
Nitrogen produced, lb./hd./day	.27	.27	.27	.27
Total N produced, lb./year	39,838,176	1,016,064	25,137	25,137
Lb. of N available to crops 1st yr.	8,565,208	172,731	5,404	4,273
Value of 1st yr. N	$1,490,346	$30,055	$940	$744

Table 4. — Break-Even Round Trip Hauling Distance for Solid Manure (5-Ton Load) at Various Prices of Commercial Nitrogen and Diesel Fuel

Anhydrous ammonia ($/ton)	Diesel fuel (¢/gal.)					
	20	25	30	35	40	45
	miles					
100	1.74	1.69	1.65	1.61	1.57	1.53
150	2.61	2.54	2.47	2.41	2.35	2.29
200	3.48	3.39	3.30	3.21	3.13	3.06
250	4.35	4.23	4.12	4.02	3.92	3.82
300	5.22	5.08	4.95	4.82	4.70	4.58
350	6.09	5.93	5.77	5.62	5.48	5.35

Table 5. — Break-Even Round Trip Hauling Distance for Liquid Manure (6-Ton Load) at Various Prices of Commercial Nitrogen and Diesel Fuel

Anhydrous ammonia ($/ton)	Diesel fuel (¢/gal.)					
	20	25	30	35	40	45
	miles					
100	2.21	2.15	2.09	2.03	1.98	1.93
150	3.32	3.22	3.13	3.05	2.97	2.89
200	4.42	4.30	4.18	4.07	3.96	3.86
250	5.53	5.37	5.22	5.08	4.95	4.82
300	6.64	6.45	6.27	6.09	5.94	5.78
350	7.74	7.52	7.31	7.11	6.93	6.75

Increasing hauling distances

Another consideration for livestock producers in times of soaring commercial fertilizer prices is the distance they can afford to haul livestock wastes. Estimated distances for hauling solid manure (Table 4) are based on prices of commercial nitrogen and diesel fuel. Hauling distances were found to be quite dependent on changes in the price of commercial nitrogen (anhydrous ammonia) but only slightly responsive to changes in fuel prices. This is as expected, since the value of livestock waste is a function of commercial nitrogen prices while diesel fuel costs are only a small portion of total hauling costs, which also include tractor and spreader repairs and labor costs.

Hauling distances for liquid wastes (Table 5) are slightly higher than for solid wastes because of the assumed larger capacity and lower repair costs of a liquid spreader.

As commercial nitrogen prices increase, some producers may consider purchasing or hauling away a neighbor's wastes. Any payments for manure, however, would increase hauling costs and thus reduce hauling distances.

These tables consider only the value of nitrogen in manure during the year it is applied. As noted earlier, however, there is some nitrogen carryover value, and phosphorus and potassium are also present. Considering the full nutrient value of manure would somewhat increase the break-even hauling distances.

An alternative method of calculating hauling distances is to price livestock wastes at hauling costs. This "input" price can then be compared with the equivalent input price of commercial nitrogen.

In summary, the value of manure has increased as commercial nitrogen prices have risen. This has made it possible to haul manure for greater distances and to implement more efficient waste collection systems and better methods for preserving nutrient value. Future research possibilities include developing a comprehensive valuation of manure by placing current fertilizer values on the phosphorus and potassium content of manure and evaluating the investment costs of alternative waste-handling systems.

Magnolias You Can Count On

Newly developed hybrids don't flower until after most danger of spring frost is past

J. C. McDANIEL

Woodsman, a new late-blooming hybrid, is now in propagation.

***M. liliflora* 'Nigra' has been used as one parent of several hybrids.**

Hybrid deciduous magnolias have been known and cultivated widely since the early 1800's. The most common one grown in Illinois is the saucer magnolia (*Magnolia* × *soulangiana*), frequently miscalled "Japanese magnolia" or "tulip tree." The saucer magnolia is a showy thing when in full bloom in early spring. In too many years, though, spring frosts ruin its flower display before it reaches its peak.

Now magnolia hybrids have been developed which delay their flowering until most danger of spring frost is over, and are likely to be enjoyed in more Illinois landscapes year after year than is *M.* × *soulangiana*.

Hybrids of *M. acuminata*

Some of the new hybrids have been bred between a native Illinois species and one parent of *M.* × *soulangiana*. The native species is the cucumber-tree, *M. acuminata*.

Of the 90 or so species of magnolia in the world, *M. acuminata* is the only one native to Illinois. It is a timber tree found in rich woods from Louisiana north to Lake Ontario, and is the hardiest of American magnolias.

Although *M. acuminata* makes a very handsome shade tree, it usually has not been greatly valued for its flowers, which are yellowish green in the typical form and appear after the leaves in the spring. The new hybrids of *M. acuminata* with other species have larger and more colorful flowers than *M. acuminata*, but they still retain a flowering season of late April to May, after most danger of spring frost has passed.

One such hybrid, Woodsman, has been bred in Urbana-Champaign. Its parents were *M. acuminata* and the purple-flowered Chinese *M. liliflora*. Woodsman has a tulip-like flower similar to that of *M.* × *soulangiana*, except that, instead of being pink, each flower shades from dark purple through pink, yellow, and green. The flowers bloomed in such recent unfavorable seasons as 1973 and 1974, when most other magnolia buds were frozen out. Woodsman is in propagation now in American and foreign nurseries.

Woodsman is the first hybrid between *M. acuminata* and *M. liliflora* to be marketed. However, it was bred and named after a similar hybrid had been produced by the Brooklyn Botanic Garden research staff. They patented a selection with the cultivar name of Evamaria in 1968, but it is not yet commercially available.

George Kalmbacher, recently retired taxonomist at the Brooklyn Botanic Garden, published the name *Magnolia* × *brooklynensis* to cover Evamaria and all such hybrids. The full name of the Urbana-Champaign cultivar then will be *Magnolia* × *brooklynensis* Kalmbacher, cultivar 'Woodsman'. However, nurserymen can label it just *M.* × 'Woodsman'.

The two parent species of the *M.* × *brooklynensis* hybrids are both naturally tetraploids, with a somatic chromosome number of 76. Currently botanists place them together in Subgenus *Yulania*, section *Tulipastrum*.

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They are the only species of that section, if we broaden the *M. acuminata* species to include *M. cordata,* a variety of the cucumbertree with more leaf and twig pubescence and deeper yellow flowers. This variety now is designated *M. a.* var. *subcordata* (Spach) Dandy instead of being maintained as a separate species.

There have been intervarietal hybrids between *M. cordata* and the typical *M. acuminata,* but the *M.* × *brooklynensis* clones are the first interspecific hybrids known to have involved *M. acuminata.* Woodsman, Evamaria, and some other *brooklynensis* hybrids are fertile, so they offer material for breeding additional hardy hybrid magnolias in various colors.

Other hybrids of *M. liliflora*

Much earlier *M. liliflora* was one parent of *M.* × *soulangiana.* This hybrid is the most common hybrid magnolia not only in Illinois, but also throughout the world. It was described in France in 1827 by Soulange-Bodin, who had raised it as a hybrid between *M. liliflora* and another Chinese species, the white-flowered *M. denudata.* Similar hybrids possibly were of even earlier origin in gardens of Japan, where both parent species had been introduced long before they were taken to Europe in the late 1700's.

The most widely grown form of *M.* × *soulangiana* in America is apparently one of Soulange-Bodin's several seedlings, with pink flowers. It has cultural advantages over both parents, being more wood-hardy than the usual *M. liliflora* and more likely to escape loss of flower buds from spring frosts than is the earlier starting *M. denudata.* Its flowering is still early enough that it is somewhat unreliable for much of the eastern United States.

The first *M.* × *soulangiana* hybrids were unbalanced for chromosome number (*M. denudata* has a hexaploid number of 114) and were not usually very fertile, but some of their seedlings such as the cultivar Lennei (with 114 chromosomes) are better seed producers.

Lennei has given rise to some seedlings of even higher chromosome levels, such as Rustica Rubra with 152 chromosomes and Grace McDade, which has more than 114 according to cytogeneticist Frank S. Santamour of the U.S. National Arboretum. The purple-flowered Lennei and the brighter pink Grace McDade frequently have many seeds under central Illinois conditions. Rustica Rubra tends to flower earlier for us, and loses its fertility potential to spring frosts, but in Louisiana and Alabama it often is loaded with fertile seeds.

M. liliflora recently has been hybridized with both other hexaploids besides *M. denudata* and with diploid species in other sections of the Yulania subgenus. Announced in England in 1974, *M.* × 'Caerhays Surprise' is a hybrid of *M. liliflora* 'Nigra' × *M. campbellii* subspecies *mollicomata.* Its fertility has not yet been determined.

Several recent *M. liliflora* × *M. stellata* hybrids have been bred at the U.S. National Arboretum. Although they flower later than *M. stellata* (star magnolia) and are desirable garden shrubs, they are sterile triploids ($3n = 57$) and not useful for further breeding. *M. stellata* 'Norman Gould', produced at the Royal Horticultural Society's garden at Wisley, England, is presumably a colchicine-induced tetraploid. It has been imported to try in crosses with Woodsman and other tetraploid magnolias.

U. of I. hybrids

Before Woodsman was introduced, three other promising hybrid magnolias were developed at the University of Illinois. One is *M.* × *thompsoniana* 'Urbana', a hybrid of *M. virginiana* × *M. tripetala.* (See Illinois Research, Fall, 1966.) The other two are cultivars of *M.* × *loebneri,* the hybrid between *M. stellata* and *M. kobus,* both of which are native to Japan. The two Illinois cultivars, Spring Snow and Ballerina, offer some advantages over other cultivars of *M.* × *loebneri.*

Spring Snow, with fragrant white flowers, was propagated from an original tree that still stands in the University president's garden in Urbana. Among a group of its seedlings grown on the University of Illinois Horticulture Farm, one was outstanding for its greater number of petals and even sweeter fragrance. This superior seedling was named Ballerina.

Both Spring Snow and Ballerina bloom more reliably in frosty springs here than does the slightly earlier Merrill, which is the most generally available cultivar of *M.* × *loebneri* in America. Ballerina is easy to propagate from cuttings and should appear in many American nurseries before long.

Woodsman also propagates readily from cuttings, in contrast to its *M. acuminata* parent, which must be grafted or grown from seed. Woodsman is also readily grafted on other understocks, including *M.* × *soulangiana,* the deciduous magnolia most common in American nurseries. It is too soon to say how big a tree Woodsman will make eventually, though apparently it will grow larger than *M.* × *soulangiana.*

Breeding experiments so far indicate that Woodsman and other *M.* × *brooklynensis* hybrids are cross-fertile with several other species and hybrids. In 1973 and 1974 seed was obtained in crosses of *M.* × *brooklynensis* with *M. acuminata,* with Lennei, and with another *M.* × *soulangiana* cultivar. Crossing will also be tried with *M. dawsoniana* 'Chyverton Red'. This is an English cultivar with frost-resistant flower buds. The crossing will be attempted as soon as Chyverton Red reaches flowering age in Urbana. *M. acuminata* cultivars with better yellow flower color than previously available are already flowering here, and should offer no difficulty in backcrossing with Woodsman.

The material is at hand for breeding several different colors and probably different growth habits into hardy magnolias for Illinois and other parts of the United States where the commonly available cultivars often do not fulfill their promise.

Corn Disease Is Combated With Use Of Genetic Resistance

A. L. HOOKER

THE CORN BLIGHT epidemic of 1970 heightened worldwide awareness that all major food and feed crops are vulnerable to disease and other hazards. World food and energy shortages, as well as good business sense, demand that we reduce crop losses due to plant disease.

An ideal way to control plant disease is through genetic resistance. It is not costly to the farmer, requires few daily management decisions, and causes little concern for environmental quality.

A research program in the Department of Plant Pathology is using genetic resistance to combat corn disease. The program has eight facets: vigilance, problem assessment, reaction to disease, sources of resistance, nature and expression of resistance, inheritance of resistance, breeding for resistance, and utilization of resistance in agriculture.

Vigilance

Plant disease problems change constantly. This happens as new pathogens appear, the races of current pathogens change, new crop germ plasm is introduced, and changes are made in the way crops are grown.

With vigilance, potentially important problems can be detected early. Within the last five years downy mildew (*Sclerospora sorghi*) has appeared, and anthracnose (*Colletotrichum graminicola*) has become more important in Illinois corn fields. New strains of *Helminthosporium carbonum* (leaf spot) have also been detected.

Vigilance also enabled us to bring the corn blight epidemic under control. The causal organism — race T of *Helminthosporium maydis* — was discovered in west-central Illinois in September, 1969. Work during the following winter showed that race T differed from the old race O, which had been present in the state for years. Characteristics of race T were determined and resistance to it was demonstrated, but its importance could not be predicted in the winter.

The following spring, plots were established to compare field losses caused by the two races. During the summer of 1970 these plots vividly illustrated the blight problem. They convinced visiting seedsmen that the susceptible Texas-sterile cytoplasm should be removed from production. The ultimate solution of the problem then rested on the rapidity with which resistant seed could be produced.

Every year we continue to monitor Illinois corn fields for the appearance of new pathogens and changes in the existing ones.

Problem assessment

Because funds, facilities, and people are not available to support a detailed research program on all corn diseases, some assessment must be made as to which problems most need consideration. When a new problem arises, an effort is made to determine its potential significance for Illinois agriculture. Some diseases such as the Helminthosporium blights and rust are recognized as potentially epidemic. Other diseases are believed to be of little significance to farmers but may be important in seed production fields. Still others for various reasons have never developed to destructive proportions. Some potentially damaging diseases have been kept under control for many years through disease resistance.

Reaction to disease

Plant breeders at state agricultural experiment stations continue to develop new parental inbreds used in producing hybrids with superior yield, quality, standability, and other features. These inbreds and a few hybrids are evaluated at Illinois for their reaction to numerous diseases. This makes it possible to anticipate potential weaknesses of certain hybrid combinations. The evaluations are of most value for inbreds developed in areas where Illinois disease problems do not occur.

Sources of resistance

Diverse sources of disease resistance must be available for a program of plant health to work. Many sources of resistance to the various leaf blight, wilt, virus, rust, stalk rot, smut, and other corn diseases have been identified in the Illinois program. A living inventory of seed stocks is maintained. Significant discoveries include the gene *Ht* for resistance to northern leaf blight (*H. turcicum*), the C-*cms,* S-*cms,* and other male-sterile cytoplasms with resistance to *H. maydis* race T, and the gene *rhm* for resistance to *H. maydis* race O.

Sometimes disease resistance is located in corn types from other regions of the world or even in wild relatives. The resistance genes may be linked to genes for low yield, undesirable plant type, or poor adaptability. Part of our research effort is therefore devoted to transferring the resistance genes or cytoplasms to corn types adapted to Illinois. The applied corn breeder can then use the resistant sources to generate inbreds as parents of superior hybrids.

Nature and expression of resistance

Genes and cytoplasms for disease resistance are expressed only when

A. L. Hooker is professor of plant genetics, Department of Plant Pathology.

disease is present. Therefore, efficient ways of evaluating the corn plant for reaction to each of its diseases have been developed. Most evaluations are done in the field, but some laboratory and greenhouse procedures have been developed to supplement field observations.

The resistance of corn plants to a pathogen may include several components: Fewer infection points may occur on a resistant plant than on a susceptible one. Individual lesions on resistant and susceptible plants may differ in size, pigmentation, or some other characteristic. Or reproduction of the pathogen in the lesion may be substantially delayed and reduced in a resistant plant. This component can be quite effective for pathogens like the Helminthosporium fungi, which spread within corn fields by repeated reinfections from leaf to leaf.

When several components of resistance are known, they can be combined in various ways to form a multi-component resisting plant. Such a plant is usually superior to single-component types.

Resistance is specific if it functions against some but not all biotypes of the pathogen; general if it functions uniformly well against all biotypes. To determine whether a source of resistance is of the general type is difficult. Repeated success of the resistance in agriculture, wide testing against many pathogen biotypes, and international testing are valuable here.

In the Illinois program, some of the resistances to rust and the Helminthosporium fungi are specific. Other resistances to these fungi appear to be general. Apparently there is also general resistance to corn smut and to *Diplodia zeae* and other stalk rot pathogens. Rust resistance that is expressed as a low number of pustules in the adult plant is believed to be general, accounting for the fact that corn rust is not economically important in the United States.

Biochemical and histological studies of resistance have also been made. While the knowledge gained from these studies has been interesting, it has played little part in the selection and breeding for disease resistance.

Inheritance of resistance

Designing a breeding program to utilize a resistance component becomes easier when the component's mode of inheritance is known. Research has yielded knowledge about the inheritance of resistance to several pathogens. A wide and continuous array of genetic patterns has been found. A most common type of resistance is based on nuclear genes.

Resistance to *H. turcicum* can be monogenic dominate. Two of the identified genes have been designated as Ht_1 and Ht_2. Other major genes for resistance to *H. turcicum* have also been revealed. One form of resistance to *H. maydis* is due to the recessive gene *rhm*.

For resistance to common rust (*Puccinia sorghi*), five loci have been identified, each containing a large series of alleles. Some of the genes for resistance to *P. sorghi* are very closely linked so that populations of 20,000 plants and more are needed to reveal recombinations between them.

Resistance to some pathogens depends upon a favorable interaction of two or three genes. Effective resistance is often due to the action of many genes, each with a small effect. Most of the gene action seems to be additive. This polygenic resistance is highly heritable.

Resistance to *H. maydis* race T and to *Phyllosticta maydis* (yellow leaf blight) is mainly cytoplasmic but nuclear genes are also involved.

By means of these genetic studies a collection of known genes and cytoplasms for resistance to various corn pathogens has been developed. Many of the genes and cytoplasms are now in Illinois hybrids, giving protection against disease. Others are maintained as reserve germ plasm stocks which can rapidly be utilized in hybrids as the need arises.

Breeding for disease resistance

Research on sources, nature and expression, and inheritance of resistance will have little value to agriculture or to society unless the research is translated into seed stocks for commercial hybrids. Much of our research effort is therefore concerned with breeding methods and the development of disease-resistant inbred lines or composites.

Genes for resistance to leaf blight, wilt, rust, and stalk rot have been transferred to inbred lines by backcross breeding. In developing disease-resistant composites, various methods have been used to concentrate genes for disease resistance. Some composite populations in the program have a very wide genetic base including exotic germ plasm. Most, however, are breeding composites containing some of the most adapted and productive germ plasm available in the Corn Belt.

In our breeding work we have maintained close cooperation with corn breeders in private industry, the U.S. Department of Agriculture, and agricultural experiment stations in other states.

Many improved genetic stocks, inbred lines, sources of resistance, and disease-resistant composites have been developed and released to the public.

Utilization of resistance

Information and germ plasm from the Illinois program are utilized by corn breeders and seedsmen. The gene *Ht* is now widely used in the northern part of the Corn Belt and in Europe. The resistance has effectively controlled northern leaf blight even though weather conditions in several recent years have favored disease development. The C-*cms* and to a lesser extent S-*cms* cytoplasms are now in use in Illinois and other states. These cytoplasms condition resistance to *H. maydis* race T.

Few people see corn plants completely susceptible to diseases. And while resistance to disease in hybrids may not be appreciated until it is missing, its presence is no accident. Resistance comes about because useful research is done in a fundamental way and the results are applied through the cooperation of state experiment stations and the agricultural industry.

An Alternative Approach For Producing Corn Hybrids

E. B. PATTERSON

By 1970 most hybrid corn seed in the United States was being produced without the need for detasseling plants in female rows. This was possible through the use of Texas-sterile (T-sterile) cytoplasm.

Then, in 1970, plants carrying this cytoplasm proved highly susceptible to the newly recognized T-strain of *Helminthosporium maydis*. The resulting epidemic of southern corn leaf blight forced many seed producers to return to the use of non-sterile or "normal" cytoplasm and the detasseling methods of the past.

At the same time corn breeders began seeking new ways to produce resistant hybrid seed without detasseling. One approach has been to search for nuclear genes that will provide disease resistance in association with T-sterile cytoplasm or for resistant, mutant forms of T-cytoplasm. A second approach has been to develop other types of sterile cytoplasm. Gametocides are also being tested as agents to prevent or delay pollen shed.

Still another approach is presented here: the use of nuclear male-sterile genes in conjunction with chromosome deficiencies in backgrounds of non-sterile cytoplasm.

The approach

All known male-sterile genes in corn are recessive in their expression. They may be designated by the symbol *ms;* normal gene forms, by the symbol +. Male-sterile plants have the genetic constitution *ms/ms*.

Usually, to maintain stocks of a male-sterile gene, male-sterile plants are pollinated by male-fertile plants that carry the recessive gene *ms/ms* × *ms/+*. Half of the progeny plants, then, are male-sterile (*ms/ms*) and half, male-fertile (*ms/+*), provided the *ms* and + forms of the gene are transmitted in equal frequencies to the progeny.

In such crosses, if no pollen grain carrying the normal form of the gene functioned in fertilization, all progeny would be male-sterile. This is precisely what is needed to produce male-sterile rows of female parents for commercial foundation and production fields. Such rows would not need detasseling.

To maintain stocks of *ms/+* plants in which the normal form of the *ms* gene is not pollen-transmitted, the normal gene must be egg-transmitted. This may be accomplished with the use of a chromosome deficiency, or deletion, next to a male-sterile gene. A chromosome deficiency may be designated by the symbol *Df*. Its alternative, a chromosome carrying the normal chromosome segment in the same position, may be designated by the symbol *N*.

Deficiencies for use with the procedures described here would be egg-viable. They would not, however, be pollen-transmitted. The pollen carrying the deficient chromosome would be aborted or would be unable to compete successfully with normal pollen in fertilization.

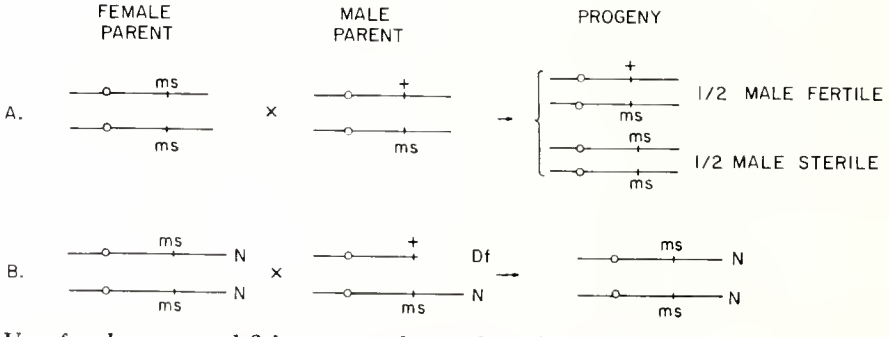
Figure 1 illustrates use of a chromosome deficiency to selectively transmit the *ms* gene. "A" (at top) shows the usual maintenance cross, which yields male-sterile and male-fertile progeny plants in equal proportions. "B" shows a similar cross in which the pollinator has a chromosome deficiency adjacent to the normal (+) form of the male-sterile gene. In this instance, if the normal gene form and the deficiency remain associated, all progeny will be male-sterile.

Very few of these simple deficiencies with the required transmission characteristics have been identified and perpetuated in corn. We are therefore investigating certain aberrant chromosome stocks which also involve chromosome deficiencies and display similar transmission characteristics. These stocks are derived initially from reciprocal translocations.

Screening and testing

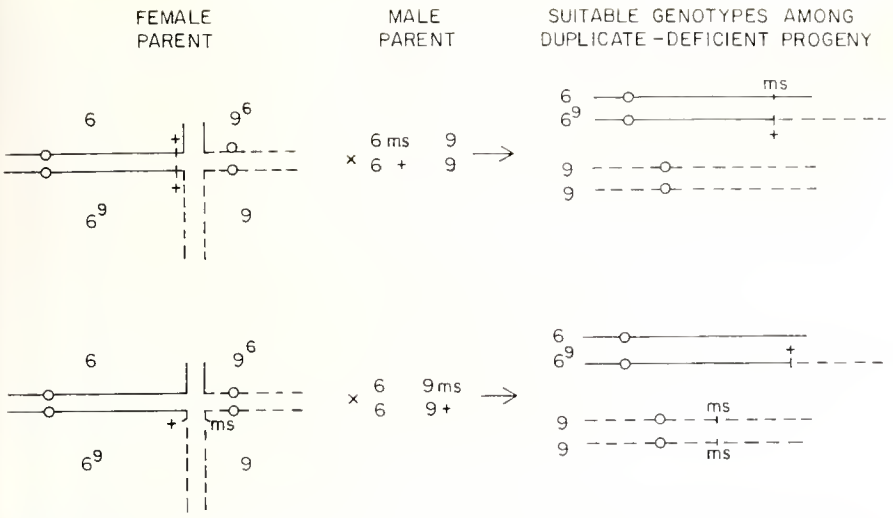
Two unlike chromosomes in corn may interchange ends after chromosome breakage. This is termed a reciprocal interchange or reciprocal translocation. The two rearranged chromosomes are fully stable and, when transmitted together, contain all the chromosomal material that was in the two normal chromosomes from which they arose. The rearranged chromosomes complement each other; spores which receive one of them must also receive the other to be chromosomally balanced.

Plants may easily be produced that



Use of a chromosome deficiency to produce male-sterile progeny. **(Fig. 1)**

E. B. Patterson is associate professor of plant genetics, Department of Agronomy.



The derivation of duplicate-deficient chromosome complements from reciprocal translocations. (Fig. 2)

derive the two rearranged chromosomes from one parent and their normal counterparts from the other parent. The spores of these plants are fully functional if they receive both normally arranged chromosomes or both interchanged chromosomes. However, in some spores an interchanged chromosome is combined with a normally arranged one. Such a spore is termed duplicate-deficient (Dp-Df); it is deficient for one of the originally interchanged tip segments and duplicated for the other one.

Figure 2 shows how Dp-Df progeny are derived from plants carrying a reciprocal translocation. At left is the pairing configuration of interchanged chromosomes with their normal counterparts in cells which give rise to spores. Shown at right are Dp-Df plant types resulting when a Dp-Df egg with the chromosome combination $6^9 + 9$ is fertilized by a sperm carrying the *ms* gene from the male parent.

These Dp-Df plants produce two types of pollen, $6^9 + 9$ and $6 + 9$. The first type of pollen is deficient and cannot compete with the second type. So long as the normal (+) form of the male-sterile gene remains associated with the 6^9 chromosome, it is not pollen-transmitted. Thus, if such Dp-Df plants are used as male parents in crosses to male-sterile plants, the progeny will be male-sterile.

At the top of Figure 2, the male-sterile gene is located in the chromosome 6 portion of the 6^9 chromosome; as shown at bottom, the same reciprocal translocation might be used in conjunction with a male-sterile gene in the chromosome 9 portion. The two alternatives differ only in where a male-sterile gene is located in relation to the interchange point in the 6^9 chromosome.

The portion of chromosome 9 in the 6^9 chromosome does not compensate for the segment of chromosome 6 which it replaced. Since the point of interchange is itself the terminus of the deficient segment, regions on either side of this point are physically and genetically linked to the deficiency.

In divisions leading to spore formation, corresponding portions of like chromosomes undergo physical pairing. At this time exchanges may occur between the partners, giving rise to new gene associations. The normal (+) form of a male-sterile gene on an interchanged chromosome may be transferred to a normally arranged chromosome and become fully transmissible through pollen. In Dp-Df combinations selected for commercial use, the frequency of normal spores carrying the normal form of a male-sterile gene derived in this way should not exceed about 5 per thousand. Thus far, we have identified four specific Dp-Df complements which meet this criterion. Source stocks from which these complements may be derived were released to commercial breeders in 1972.

Commercial procedures

As a preliminary to commercial use, reciprocal translocations and male-sterile genes are converted to inbred lines which will be used as female parents, or components of female parents, in production of hybrid corn. Crosses are then made of parental types shown in Figure 2. Suitable Dp-Df plants in the progeny are self-pollinated to propagate duplicate-deficient stocks and are crossed as male parents to male-sterile plants of the same line. The latter cross confirms the constitution of the Dp-Df male parent and at the same time produces seed that will give virtually all male-sterile plants for use in female rows in foundation or production fields.

Table 1 summarizes the production of male-sterile seed stocks in foundation fields. Female rows consist of male-sterile plants of an inbred line. For simplicity, male-fertile plants in male rows are diagrammed as carrying a simple terminal chromosome deficiency since use of such plants is analogous to the use of duplicate-deficient plants.

If both female and male rows are derived in the same inbred line, seed produced on the female rows will give male-sterile plants of the inbred line. If female and male rows con-

Table 1. — Production of Male-Sterile Seed Stocks in Foundation Fields

Female row	Male row	Progeny
ms N / ms N	+ Df / ms N	
Inbred A	Inbred A	Male-sterile inbred A (*ms* / *ms*)
Inbred A	Inbred B	Male-sterile hybrid (A X B) (*ms* / *ms*)

Table 2. — Production Field Procedures Employing Genic Male Sterility

Female row	Male row	Hybrid for sale to farmer
Inbred A (*ms*/*ms*)	Standard inbred B (+/+)	Single-cross hybrid (A X B) (*ms*/+)
Hybrid A X B (*ms*/*ms*)	Standard inbred C (+/+)	3-way cross (A X B) X C (*ms*/+)
Hybrid A X B (*ms*/*ms*)	Standard hybrid (C X D) (+/+)	4-way cross (A X B) X (C X D) (*ms*/+)

sist of different inbred lines, seed borne on the female rows will yield male-sterile plants of the single-cross hybrid. Seed produced on male-fertile plants in male rows by self- or sib-pollination may be used to plant male rows in later generations.

Production field procedures are summarized in Table 2. Male-sterile seed stocks of inbred lines or single crosses for use as female rows are derived by procedures shown in Table 1. Male rows consist of standard versions of inbred lines or hybrids now used by the seed industry, since they are natural restorers of genic male sterility. All plants in production fields have normal chromosomes and all plants of the hybrids will shed pollen in farmers' fields.

Current status

Commercial breeders now have four options in choosing duplicate-deficient chromosome complements. Evaluation of these options depends upon several criteria that may be largely influenced by the stocks' vigor and performance in specific inbred backgrounds. Conversion to inbred lines is now nearing the point at which some comparisons can be made. Efforts are also under way to extract Dp-Df plants at partial stages of conversion and to increase seed stocks for pilot tests in the field.

Work continues in screening for additional Dp-Df complements and in exploring methods to facilitate commercial production of the required stocks.

Parturition in the Pig

PHILIP DZIUK

BIRTH is probably the most dramatic event in the life of an animal. The fetus goes from the protected environment of the uterus to the cold world in a matter of a few hours. For months, the fetus has had no real concern over food, oxygen, temperature, diseases, or locomotion. The mother has looked after all this. Now suddenly at parturition the fetus is faced with a relatively hazardous trip through the birth canal, followed by life on its own.

In the pig, the birth process is directly or indirectly responsible for more deaths than any disease or deficiency. About 7 percent of all normal, fully formed piglets that were alive in the uterus just before birth are stillborn. Of the piglets that are born alive, about 13 percent die within 48 hours of birth from damage suffered during birth. Together these losses account for the death of 20 percent of the pig crop. In Illinois alone, more than 12,000,000 piglets are born each year, and about 2,400,000 are lost. Assuming there are 10 pigs in a litter, this loss is equivalent to 240,000 complete litters.

Since only a few pigs in each litter are affected, relatively little effort has been made to study and correct the problem. In the last several years, a number of studies have been conducted at the Illinois Agricultural Experiment Station in an attempt to understand the normal birth process and then possibly to reduce the number of deaths due to parturition.

Philip Dziuk is professor of animal science.

Order of birth

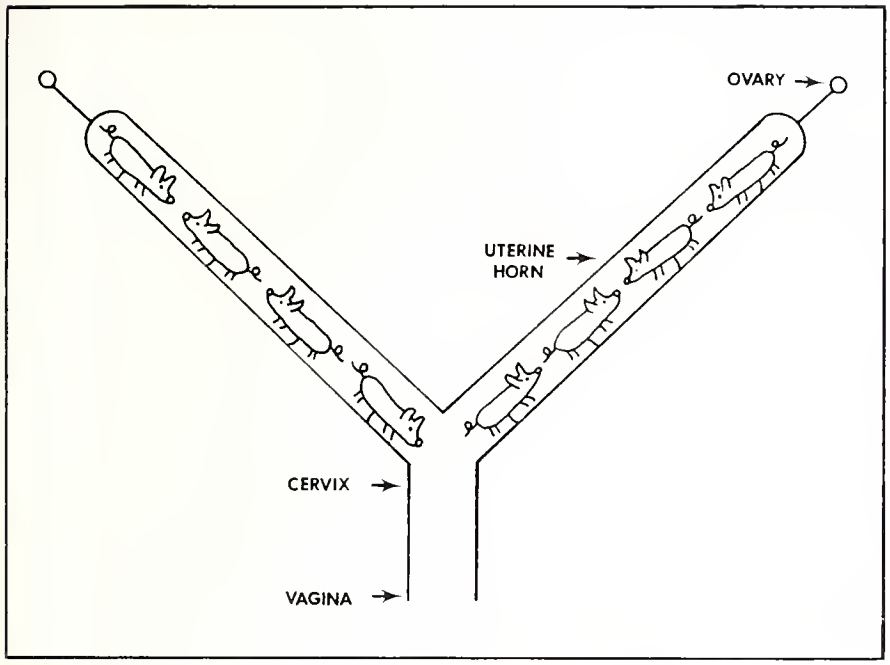
The uterus of a pregnant pig is shown in the diagram on page 19. As we began our study, a basic question arose as to whether the piglets closest to the cervix were the first to be born or whether perhaps a piglet farther away could "leapfrog" over the closer ones and be born first. We also wondered whether the piglets in one uterine horn were all born before any piglets from the other horn or whether births alternated from the two horns.

To determine the order of birth, we first injected dye through the uterine wall into the ears or shoulders of the fetuses, using a different pattern for each fetus. The position of the fetus in the uterus was then recorded. At farrowing, the spots of dye allowed us to identify which piglets were born first, second, and so on. Piglets were born in order of nearness to the cervix and did not "leapfrog" out of turn. The usual sequence of birth was for one piglet to be born from one horn and the next to be born from the other.

Head first or tail first?

By examining the head-tail orientation of fetuses in the uterus of pregnant sows, we found that fetuses do not turn around in the uterus during gestation. We also found that half of the fetuses in the segment of the uterus nearest the cervix were headed toward the cervix while half were headed away from the cervix. The first half of the litter was equally divided between head-first and tail-first presentations. Three-quarters of the fetuses in the tip of the uterine horn were headed toward the cervix. The last few piglets born came head first 70 percent of the time.

These findings tend to disprove the notion that stillbirths occur more often in piglets presented tail first.



Aids to survival

By recording the time of birth of each piglet and noting whether it was born live or stillborn, we arrived at several conclusions. When the interval between piglets is 15 minutes or less, they are likely to be born alive, but when the interval is 20 minutes or more, the second piglet is more likely to be stillborn. When total farrowing time exceeds 200 minutes, stillbirths increase.

We are now experimenting with uterine muscle stimulants to shorten the intervals between piglets and hence reduce stillbirths.

Perhaps one of the most significant observations was that 95 percent of the piglets survived if their birth was supervised. About 75 percent of those born at about the same time without supervision survived.

Supervision entailed watching the birth of each pig and then drying it off and tattooing a number in its ear. The increased survival of piglets might be weighed against the cost and labor involved in supervision. If farrowings could be scheduled for an appointed time, survival of piglets might be increased with little extra cost.

Length of gestation

Does the mother or the fetus determine the length of gestation? Do the fetal hormones tell the mother, "I'm done," and initiate parturition; or do the maternal hormones tell the fetus, "You're done," and start birth?

To study possible answers to this question, we surgically removed heads of fetuses at 40 days of gestation. The head contains the brain and the pituitary, which are the prime regulators of the fetal hormones. The fetuses continued to grow and develop without the head, but instead of farrowing at about 114 days as is usual in the pig, gestation continued to at least 120 days, at which time the fetuses were removed by hysterotomy.

This shows that in the pig it is predominately the fetus that determines the length of gestation, as it is in the sheep, cow, and human.

The possible role of the maternal ovary in the initiation of parturition was studied by surgically removing part of the ovary and by transplanting ovaries to other parts of the body. Neither the amount of ovarian tissue nor the location of the ovaries affected the levels of hormones or the length of gestation. Apparently, the mother abides by the whims of the fetuses.

The loss of pigs from the birth process is greater than from any other cause. Perhaps as understanding of parturition increases and greater use is made of this knowledge, the survival rate of the piglets will also increase.

FARM BUSINESS TRENDS

YOUNG FARM FAMILIES of today may face quite different problems than did their parents. Even so, farming may retain important advantages over many other occupations.

Here are some of the prospective differences for young farmers: Farm operating costs are much higher, and may increase more rapidly than in the past. Production per acre and per man seems likely to increase less rapidly. World food needs will grow faster, but market demand may expand more slowly. Government retraints on farming — federal, state, and local — will become much more extensive.

Total farm operating costs have increased about 60 percent since 1972. Recent prices for fertilizer were up 33 percent from those of just a year before. Rising prices for farm inputs are primarily the results of increasing costs for labor and growing scarcities of fuel, iron ore, and many other raw materials required to produce farm equipment and supplies. Labor costs seem likely to increase more rapidly in the future, and supplies of energy and other resources will be more difficult to obtain from the earth. We do not have institutions — government agencies or private corporations — with the financial resources to produce the energy and materials that will be needed 20 years from now. Because of the high ratio of costs to gross income, farmers' net income may be even more variable than in the past.

The beginning farmer of 20 to 25 years ago met increasing costs by producing more per acre and per man. For example, during the 20 years ending with 1973, national average yields of corn were boosted from 40 bushels to 92 bushels — 130 percent. Acreage farmed per man increased a similar amount. Production per man increased about 300 percent. We doubt that farmers can match that during the next 20 years.

U.S. farmers gained greatly from a rapidly growing export demand for their grains and soybeans after World War II. Western Europe and Japan have been our best customers. World population, and thus food needs, will increase more rapidly during the next 25 years than during the past quarter century. But the biggest growth of population will be in the poorest countries, where the people have little buying power. Political and economic conditions seem unlikely to convert world hunger into effective market demand for our farm products.

Pioneer farmers had almost complete freedom to use their land as they desired. However, as population has increased, citizens have exerted increasing controls over farming and other productive activities. In some cases regulatory agencies will have conflicting assignments and policies. Their programs will make it increasingly difficult for farmers to produce food efficiently and profitably.

Despite these problems — and many others — our young farm families seem to have advantages and opportunities that are the envy of many of their fellow citizens. Most farm families can live in uncrowded surroundings and breathe unpolluted air. In this, farm people are way ahead of their city cousins who are emigrating from large cities to smaller towns and rural communities. There are economic rewards for superior performance in farming. Farmers usually accumulate more savings, in the form of personal property and real estate, than do their brothers who leave the farm. Finally, the growing concern about food supplies may enhance the prestige of farmers in our society. — *L. H. Simerl, Professor of Agricultural Economics*

This will be Professor Simerl's last column before his retirement July 31. His clear and penetrating economic analyses have been a regular feature of ILLINOIS RESEARCH since its beginning in 1959.

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IN THIS ISSU

Two of the developers of new soybean beverage, L. Wei and M. P. Steinbe toast each other with th product (page 3).

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CONTENTS

Fall, 1975 Volume 17, Number 4

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NEW HEAD OF AGRICULTURAL ECONOMICS

DANIEL I. PADBERG, coming to Illinois from Cornell University, assumed his duties as head of the Department of Agricultural Economics on August 25. He succeeded Richard L. Feltner, who is now Assistant Secretary of Agriculture.

A native Missourian, Padberg attended the University of Missouri, receiving his B.S. degree in agriculture in 1953 and his M.S. degree in agricultural economics in 1955. After serving in the U.S. Navy from 1955 to 1958, he continued his education at the University of California, Berkeley, where he was awarded a Ph.D. degree in agricultural economics in 1961.

Upon completing his studies in California, he went to Ohio State University as assistant professor of agricultural economics and rural sociology. He left Ohio in January, 1965, to serve as project leader in retailing for the National Commission on Food Marketing. From July 1966, until 1975, he was first associate professor, then professor at Cornell University, teaching undergraduate and graduate courses, conducting research, and carrying on extension work in agricultural marketing.

While on the Cornell staff, he spent a sabbatical year (1972-73) as a Simon Research Fellow at the University of Manchester, England. He was a member of the White House Task Force on Farmer Bargaining in 1968; has been a consultant to the Cost of Living Council since 1973; and has been on the Food and Nutrition Board of the National Academy of Sciences since 1974.

He has written two books, *Economics of Food Retailing* and *Today's Food Broker,* and is the author or co-author of numerous technical and popular articles on such topics as market structure and food retailing. — *G. W. Salisbury*

A New Illinois Soybean Beverage:

Tasty, Smooth, Nutritious, and Economical

L. S. WEI, M. P. STEINBERG, and A. I. NELSON

SOYBEAN MILK has been a food staple in the Orient for many centuries. It is conventionally made by soaking the soybeans, grinding them with water, cooking the slurry, and then filtering to remove sludge.

Unfortunately, the Oriental beverage has a distinct painty flavor. This off-flavor is quickly generated by lipoxygenase enzyme whenever the beans are ground and exposed to water.

A bland soybean milk would be of particular interest in the Occident as an economical source of high-quality protein. It would be especially valuable for people intolerant to lactose.

Numerous procedures have been developed to improve on the Oriental process as to both flavor and protein recovery. Cornell University and the Northern Regional Research Laboratory of the U.S. Department of Agriculture have made specially valuable contributions. However, a recurring problem has been the grainy mouth feel caused by colloidal instability or instability of suspension.

This problem has been solved with a beverage developed by the Food Processing Laboratory in the Department of Food Science. The beverage not only has a smooth mouth feel but also is completely free of painty flavor. We prevent the off-flavor rather than try to volatilize it or mask it with spices. This is done by hydrating and cooking the whole soybeans, thus inactivating the lipoxygenase enzyme.

L. S. Wei is associate professor of food science; M. P. Steinberg, professor of food engineering; A. I. Nelson, professor of food processing.

At least 1,000 people have sampled the University of Illinois beverage. Invariably, their comments have been very favorable.

An 11-step process

Any of the Illinois varieties of soybeans can be used to prepare the beverage. The process has a number of variations, but the preferred one consists of the following 11 steps:

1. Hydrate whole soybeans in water containing bicarbonate of soda (baking soda).
2. Blanch, or cook, for 30 minutes in boiling water containing baking soda.
3. Grind with enough water to give 12 percent total solids.
4. Heat to 200° F.
5. Homogenize at 3,500 pounds per square inch (psi).
6. Add water to adjust protein to desired level.
7. Neutralize to a pH of 7.2.
8. Add sugar, salt, and flavor.
9. Heat to 180° F.
10. Homogenize at 3,500 psi.
11. Bottle.

We prefer to add 0.5-percent bicarbonate of soda to both the hydration water and the blanch water. The soda is especially valuable in the blanch water.

The product obtained at the end of Step 5 is called "Soybean beverage base." It can be used to prepare such dairy analogs as yogurt and ice cream, as well as milk. It can also be frozen or dried for future use.

Trypsin inhibitor

In developing the beverage, we had to solve a number of problems. One was how to inactivate the protein in raw soybeans that inhibits trypsin, a natural digestive enzyme. We developed a number of treatments that completely destroyed the trypsin inhibitor. Six are shown in Table 1.

Table 1. — Hydration and Blanch Combinations That Destroy Trypsin Inhibitor

Hydration		Blanch	
Solution	Hr.	Solution	Min.
0.5% bicarb.[a]	12	0.5% bicarb.	5
Water	12	Water	5
Water	12	0.5% bicarb.	5
0.5% bicarb.	4	0.5% bicarb.	10
None		0.5% bicarb.	20
None		Water	20

[a] Bicarbonate of soda or baking soda ($NaHCO_3$).

Hydrating the beans before blanching them greatly reduced the time needed to destroy the inhibitor (Table 1). However, when the whole, dry soybeans were simultaneously hydrated and blanched, as in the last two treatments, the product was also satisfactory in this regard.

Tenderization and homogenization

The more tender the beans, the better the beverage. To measure tenderness after various treatments, we used a tenderometer. A value of more than 300 pounds per 100 grams on the tenderometer indicated that the beans were too tough to give a good homogenized product.

Dry soybeans that were blanched in water for 30 minutes had a tenderometer value of 340 and the resulting beverage was poor (Table 2).

Table 2. — Tenderization and Homogenization, Dry Soybeans

Blanch 30 min.	Tend. volue, lb./100 gm.	Homog. °F.	Homog. Psi	Beverage quality
Water	310	180	3,500	Poor
Bicarb.[a]	185	180	3,500	Fair
Bicorb.	185	210	4,500	Good

[a] 0.5% bicarbonate of soda.

Table 3. — Tenderization and Homogenization, Hydrated Soybeans

Blanch, bicarb.	Tend. value, lb./100 gm.	Homog. °F.	Homog. Psi	Beverage quality
5 min.	250	180	3,500	Fair
5 min.	250	210	8,000	Excellent
20 min.	165	180	3,500	Excellent

However, adding bicarbonate of soda to the water tenderized the beans enough to give a fair product. Increasing the homogenization temperature and pressure raised the product rating to good.

When the soybeans were hydrated before blanching, a satisfactory tenderness could be obtained in a much shorter blanching time (Table 3). But, as with the dry beans, increasing temperature and pressure of homogenization improved the product, whatever the tenderometer value.

Separate studies confirmed the value of a high temperature and pressure during homogenization. Temperature was found to be especially important for the first homogenization pass (Step 5 of the preparation process). An excellent product was obtained with a temperature of 200° F. for the first pass, whether the second one (Step 10) was done at 60° F. or 180° F. A temperature of 60° F. for the first pass and 180° F. for the second pass gave a product that rated very good. Quality was lower, though still considered good, when a temperature of 60° F. was used both times.

For pressure, the second pass proved to be more critical than the first one. A high second-pass pressure can overcome a low first-pass pressure, as shown by the following figures:

First pass, psi	*Second pass, psi*	*Mouth feel*
1,500	3,500	Poor
1,500	5,000	Very good
1,500	6,000	Excellent
2,500	2,000	Poor
2,500	4,000	Good
2,500	5,000	Excellent

For most economical homogenizer operation consistent with high quality, we settled on 3,500 psi for each pass.

Colloidal stability

Instability of the colloidal system, causing a grainy mouth feel, can be a severe problem. Beverages made with both whole soybeans and hulled beans were judged for mouth feel after standing for various lengths of time. No graininess was detected in either beverage. The presence of hulls thus did not seem to affect the product's stability.

This judgment was confirmed by an objective measure of colloidal stability. Bottles of beverage made with both whole and hulled beans were allowed to stand for 4 days at 34° F., after which samples were drawn from the tops and the bottoms of the bottles. The contents of each bottle were then well mixed and a third sample was drawn. Total protein was determined for each sample. The protein for all samples ranged from 3 to 3.3 percent, indicating that it did not settle and did not rise. Total solids determination gave the same picture.

In other tests, we found that viscosity was increased by both the presence of hulls and increasing protein concentrations in the beverage. Yet neither variable affected stability. It was concluded that the stability of this beverage is not related to its viscosity.

Later, we found that the pasteurized beverage, both with and without hulls, remained stable at 34° F. for over 2 months. The question then arose as to whether particle size was responsible for this amazing stability.

Coulter Counter measurements on a 1:4000 dilution of the beverage showed that about 10 percent of the particles were over 10 microns in diameter and 80 percent were in the range of 3.4 to 7.3 microns. Even more interesting, no particles were smaller than 2.7 microns. Yet this size is well above that normally considered the upper limit for colloidal particles and falls in the range for unhomogenized milk. Thus, particle size distribution is not responsible for the good stability of this beverage.

Further studies showed that the oil in this beverage is bound by complex chemical formation. Therefore, it is now believed that proper tenderization of the soybeans, combined with homogenization of the slurry, causes hydrophilic protein-lipid complexes to form. This keeps the protein from settling and the oil from rising.

Protein and solids recovery

Crude protein balances showed that the beverage retained 95 percent of the crude protein in the soybeans. The soak and blanch solutions were then assayed for true protein by the Biuret test. This showed a loss of less than 1 percent. The final beverage therefore contains essentially all of the true protein present in the soybean.

In total solids balances, 89 percent of the total solids in the raw soybeans were recovered in the beverage. The 11-percent loss is actually a plus, since a substantial portion of the loss consists of oligosaccharides, the constituents reported to be responsible for flatulence.

Beverage to be marketed

The University of Illinois Foundation has recently patented this process in the United States and in a number of other countries. Already three U.S. companies and several foreign firms have been licensed to use the process in manufacturing the beverage, yogurt, ice cream, and similar products.

We hope that some of these products will appear in your local supermarket before too many months have passed.

Tassel Trivia:

Little-known facts about corn

R. R. JOHNSON and R. J. LAMBERT

Tassels from (A) normal corn, (B) lg-1 corn, (C) lg-2 corn. Changing just one gene can reduce the number of tassel branches by as much as 96 percent.

NOWADAYS many people, enchanted with trivia, are likely to spice their conversations with such items as the gestation period of elephants, or the name of the man who invented barbed wire. A few unusual facts that we uncovered in a recent experiment may help the corn producer hold up his end of the discussion, and may also provide food for thought on possible future changes in corn hybrids.

We experimented with two hybrids, each of which had one normal and two liguleless leaf types (lg-1 and lg-2). The normal leaves, which were comparable to commercial types, grew from the stalk at an angle of 61° to 67° from the horizontal. The liguleless leaves were more upright, with the angle ranging from 75° to an almost vertical 89°.

The corn was grown in 20-inch rows in an irrigated field at 31,000 plants per acre. Pollination lasted 5 to 8 days, and grain yields were 182 to 209 bushels per acre. Tassels were harvested before and after pollen shed.

Tassel number

Either lg-1 or lg-2 can be incorporated into a hybrid by changing a single gene. Introducing the liguleless trait also decreases the size and number of tassel branches (see illustration). Thus we have Trivia Number 1: By changing just one gene, we reduced the average number of tassel branches by as much as 96 percent — from 13.0 to 0.5.

Pollen loss

To those who have itched and sneezed their way through a cornfield during pollination, it is obvious that there is a lot of pollen out there — but just how much?

Tassel dry weights before and after pollen shed showed that 31 to 47 percent of the initial weight was lost during pollination. Multiplying the loss in tassel weight by the plant population provides Trivia Number 2: In our field the amount of pollen shed ranged from 72 to 303 pounds of dry matter per acre.

This may seem insignificant; yet if the difference in dry weight from these two extremes (231 pounds) had been channeled into grain production, we would have produced almost 5 more bushels of grain per acre. And if we also channel into production the extra energy required to grow the large tassel, yields could be increased by a total of 9.5 bushels per acre.

Nutrient loss

What is the nutrient loss in pollen shed? We analyzed the nutrient content in the tassels after each harvest and converted the values into the net change in nutrients per acre. We found that calcium increased in the tassel while the other elements decreased (see table).

Trivia Number 3: In our field, the tassels from normal-leafed hybrids lost an average per acre of 9.7 pounds of elemental nitrogen, 1.3 pounds of phosphorus, and 4.7 pounds of potassium during pollen shed. With its smaller tassels, the liguleless corn lost slightly less. Most pollen not used for fertilization would eventually fall to the soil, where decomposition would return nutrients for future use.

R. R. Johnson is assistant professor of crop production; R. J. Lambert, associate professor of plant genetics.

Change in Nutrient Content of Tassel During Pollination, Average of Two Hybrids

Nutrient	Leaf type		
	Normal	lg-1	lg-2
Nitrogen, lb./A.	−9.7	−7.9	−5.2
Phosphorus, lb./A.	−1.3	−1.0	−0.7
Potassium, lb./A.	−4.7	−3.5	−2.2
Magnesium, lb./A.	−0.4	−0.4	−0.3
Calcium, lb./A.	+0.5	+0.1	+0.2
Zinc, gm./A.	−4.4	−3.1	−2.7
Boron, gm./A.	−0.4	−0.5	−0.5

Smaller tassels, bigger yields

Seen from an airplane or hilltop, a cornfield is a sea of tassels with very few leaves visible. Large tassels shade the leaves, reducing the amount of solar energy to reach them, which in turn reduces the photosynthetic output of the plant and the vigor of its growth. The corn tassel contains little chlorophyll, dies soon after pollination is complete, yet persists through the rest of the growth cycle with no known function.

Smaller tassels will use less energy to produce pollen and will reduce shading of the leaves. Of course the tassels must be large enough to provide reserve pollen to assure adequate fertilization, especially in stress environments. However — and this is not trivial — plant breeders may be able to reduce tassel size without any adverse effect on pollination, and to provide the potential for increased grain yield.

Professor Lehmann's "Mile-Line" Put Electricity on Illinois Farms

DELBERT T. DAHL

THE LATE 1930's and early 1940's marked the passing of the kerosene-lamp era from the Illinois farm scene. Today these lamps are decorator items sought at public sales and in antique shops.

The growth and use of electricity on farms today is well known. But there's a piece of history — largely Illinois-based — that some people would say has been either overlooked or forgotten. It covers the 20-year period that led to the end of the kerosene-lamp era.

A key personality was Emil Wilhelm Lehmann, known as "Prof" to all his acquaintances. Lehmann came to the University of Illinois in 1921. As he saw it, farmers' failure to recognize the importance of electrical power and mechanization was the main barrier to farm modernization. At that time, less than 10 percent of rural America was served by electricity. Lehmann wanted to show farmers that electrical equipment could save them money as well as provide convenience and comfort.

He told his staff: "It isn't that we don't know how to help the farmers; it's just that they don't want to be helped. It's as if they're afraid of us — or maybe they're just afraid of changing."

It's easy — with the advantage of today's viewpoint — to see why Illinois farmers were "afraid of changing." A severe depression in the early 1920's was making many of them nearly destitute, and they were battling to become self-sufficient. They were hardly inclined to believe that a small investment in modernization could bring them a happier life.

Delbert T. Dahl is Extension communications specialist.

Farmers weren't the only people whom Lehmann had to persuade: He also had to convince power suppliers that farmers would use electricity and that they could earn a profit by networking those many miles of rural roads with poles and lines. Neither job was easy. But Lehmann wasn't put down easily either. He had a plan and he put it into action.

The "mile-line" is built

With the cooperation of local power companies, he began an experiment of his own in 1925 — a 32-month study of electricity use in a rural area near Tolono. Ten farms were wired for the study. Soon people began referring to the power line supplying these farms as the "mile-line."

Lehmann wanted to determine whether the farm families would use electricity enough to make the installation profitable for both the farmers and the utility companies. More important, from his point of view, the line provided an opportunity to demonstrate that electricity and agriculture worked well together.

In addition to lights, all 10 families were given refrigerators, vacuum cleaners, and cream separators. Utility motors, washing machines, dishwashers, food mixers, ranges, grain elevators, electric ironers, and a variety of other equipment were also made available. Fifty years ago, each item was a luxury.

Some results of the study

The farm women were asked to keep detailed records of the way they used their time. Soon it became clear that electric washing machines and vacuum cleaners alone could save each housewife as much as 10 hours a week, leaving more time for gardening, poultry raising, and other profit-making activities.

Lehmann ranked an electrically powered water system high on the list of items "essential to a modern home." Ranking equally high was electrial lighting. Use of lights increased sharply in the winter as the farm families found a new way to lengthen the short days.

Lights were also important to the people who did farm chores. Lehmann wrote in a 1929 Agricultural Experiment Station Bulletin: "Since approximately 50 percent of a farmer's time is devoted to work about the farmstead, a large part of which is doing chores in the early morning and in the evening after dark, electric lights save time and reduce the possibility of accidents and fire. They fill a very definite need in improving living and working conditions both inside and outside the home."

On various farms, electricity was used to pump water, elevate ear corn, and even dry corn and small grain. Tests at a number of research centers had already established that controlled lighting could increase egg production by as much as 21 percent during the winter, when prices were high. The Tolono experiment bore out the earlier findings and introduced the system to Illinois.

The study indicated beyond any

Happiness is a new electric washing machine.

doubt that there was a place for electricity on the farm. On the 10 test farms, only draft horses and tractors supplied more energy than did electricity.

Lehmann made good use of the data from the Tolono experiment. He and Ralph Parks, Extension agricultural engineer, held meetings throughout Illinois to drum up support for rural electrification and to help local cooperatives organize. And Lehmann worked long and hard with utility companies to develop equitable rates.

Support and desire grew, but still nothing happened. Lehmann and the farm interest groups throughout the state knew they'd have to bypass the utility companies and look to Washington for meaningful action. And that's what they did.

REA finally brings electricity

The Rural Electrification Act of 1936 was drawn up by the Vice President of the United States in consultation with the National Federation of Farm Bureaus and the president of the Illinois Agricultural Association. Illinois, one of the most progressive and prosperous farm states, had long been recognized in Washington as a leader in the fight for rural electrification. Lehmann had spearheaded that fight.

Victory came on May 20, 1936, when the Act was signed into law by President Roosevelt. Soon the new Rural Electrification Administration (REA) was making loans to farmers who worked together to extend lines to their property.

Frank Andrew, a retired University of Illinois Extension agricultural engineer, recalls how they got electricity on his home farm in Macoupin County:

"I rode my bicycle up and down the road to contact my neighbors and tell them what electricity would mean if we could get all the neighbors signed up and get a co-op organized. One fellow said, 'Well, I wouldn't use it,' and another said, 'I don't want those lines by my place. Those wires will fall down and kill my cows.' "

But most of the farmers in Macoupin County did want electricity, and it finally came to Andrew's home farm in 1940. "I already had the house wired," he recalls. "I'd done the wiring myself. It was a great day when they came by and turned on the transformer. The first thing I did was run down to the old cellar — just a dark hole in the ground. I could hardly believe what I saw when I turned on the light. I'd seen it with a kerosene lantern and a candle, but I'd never seen it illuminated like that before."

Mile by mile the poles were set and the wires were strung. And farm home after farm home began learning the many advantages of electricity — a real key to farm modernization.

But in Illinois — and maybe for much of the nation — the start of it all was "Prof" Lehmann's "mile-line" down near Tolono.

Relative Costs of Wall Construction for Underfloor Manure-Storage Tanks

R. L. HUHNKE and J. O. CURTIS

THE MAJOR concern facing anybody planning to buy a confinement swine unit with underfloor manure storage is the large initial investment. Much of this investment goes into constructing the manure-storage tank.

Most storage tanks in operation today are built of reinforced concrete. This material is strong and durable and is relatively low-cost when used as the floor and footing of the tank. However, it becomes much more expensive when used for the tank wall. This is due to the cost of material and labor for the forms, which is sometimes double the cost of the material for the wall itself.

Four types of construction

Because of the costliness of reinforced concrete, we have investigated alternative methods of wall construction. Material and labor costs for four methods were compared:

1. Reinforced concrete.
2. Reinforced concrete masonry.
3. Reinforced surface-bonded construction (concrete masonry units stacked without mortar and with a surfacing material applied to the sides).
4. Treated wood (vertical studs with plywood sheathing on the exterior).

Earth loads

The various tank walls were designed to resist active earth pressure and a specified surcharge load. The general nature of the soil pressures against a tank wall is shown in Figure 1.

Two earth pressures (equivalent fluid pressures) due to different soil conditions were assumed. One was the pressure resulting from the action of a soil with a high water table or poor drainage (or both). This pressure was simulated by a load of 60 pounds per square foot per foot of depth (psf/ft.) or 60 pounds per cubic foot (pcf).

The second earth pressure assumed was that resulting from a moderately drained soil. This was simulated by a load of 30 pcf. With this load it was stipulated that gravel and adequate drainage tiles be placed around the perimeter of the tank wall.

A surcharge of 100 psf was added to each earth load to simulate the effect of a vehicle passing very close to the wall. The load of a vehicle is transmitted through the soil onto the outside surface of the wall.

Analysis of all costs

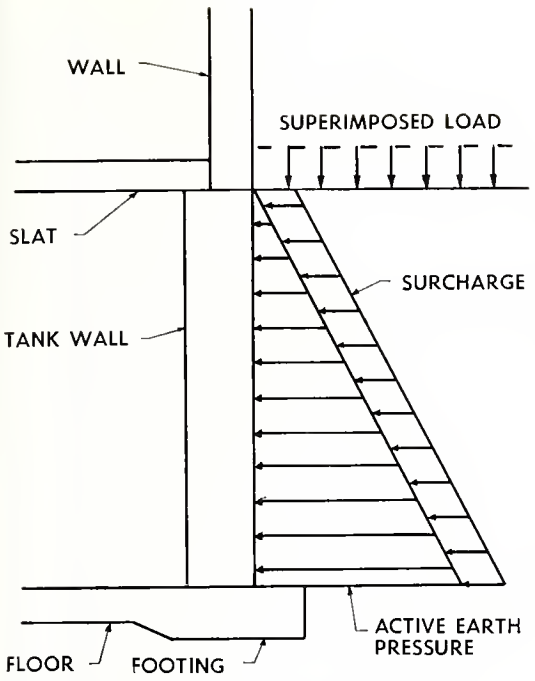
A quantitative analysis was made of all labor and material costs for each type of construction. To reduce variability, much of the cost data was taken from one source. The use of quality materials and labor was assumed, because these are essential if an underground tank is to withstand applied loads and resist deterioration.

Varying relationships

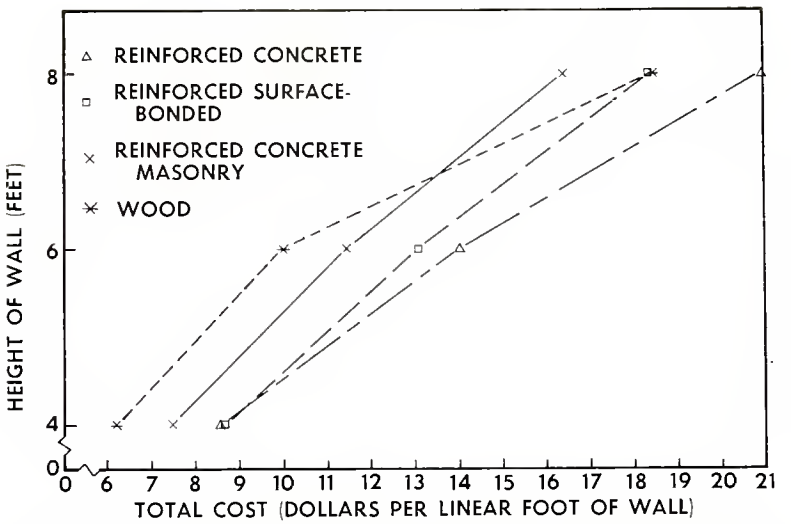
Wall height, as well as soil pressures, affects the cost relationships among the construction methods analyzed. With an earth pressure of 30 pcf plus a surcharge of 100 psf, the wood wall costs the least up to a height of just over 6 feet (Fig. 2). Beyond the 6-foot height, reinforced concrete masonry becomes the least expensive.

At the 4-foot height, the difference between the reinforced concrete masonry and wood walls is $1.28 per linear foot of wall. Assuming a building 32 by 80 feet, with two 8-foot wide pits running the length of the building, the total difference between the two types of structure is $451. At the 6-foot height, the difference is even greater — $1.43 per linear foot of wall, for a total of $503. At the 8-

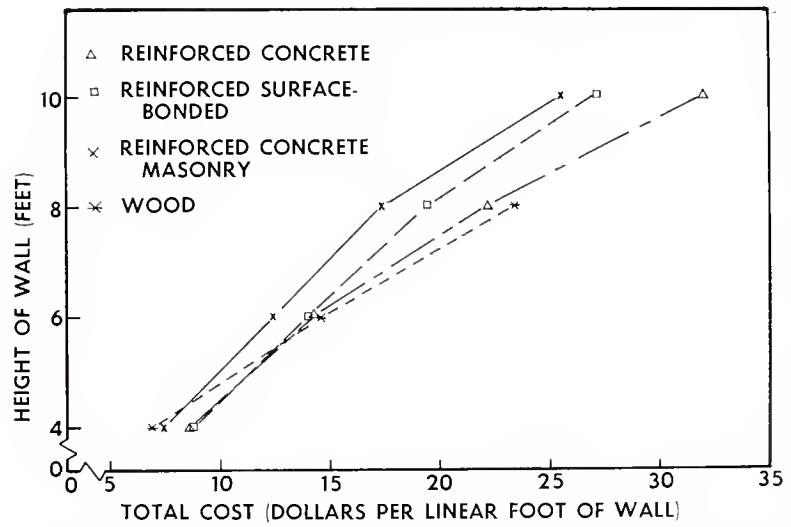
R. L. Huhnke is a former graduate assistant; J. O. Curtis is professor of agricultural engineering.



Soil pressures against a tank wall, including active earth pressure and superimposed surcharge load. (Fig. 1)



Relative costs of four types of walls, assuming an earth pressure of 30 pounds per cubic foot plus 100 pounds per square foot of surcharge loading. (Fig. 2)



Relative costs of walls when earth pressure is increased to 60 pounds per cubic foot while surcharge load remains at 100 pounds per square foot. (Fig. 3)

foot height, the reinforced masonry costs $2.02 less per linear foot than its closest competitor, the surface-bonded wall.

With an earth pressure of 60 pcf plus a surcharge loading of 100 psf, the wood wall is the lowest in cost at the 4-foot height (Fig. 3). Just above this height, though, the concrete masonry wall becomes the lowest cost alternative; and it continues to be so up to and including the 10-foot height.

At the 4-foot height, the wood wall costs $0.59 less per linear foot than the reinforced concrete masonry wall. Assuming the same size of building as before, the total cost difference amounts to $208. As already mentioned, the concrete masonry is the lowest cost at the 6-, 8-, and 10-foot heights. The maximum difference between it and the surface-bonded wall occurs at 8 feet. The difference, $2.02 per linear foot of wall, results in a total savings of $711 for the building size assumed.

With an earth pressure of 60 pcf, the cost of a wood wall rises drastically above the 4-foot height. A similar increase occurs above the 6-foot height when the earth pressure is 30 pcf (Fig. 2). These sharp cost increases are due to the need for a double stud member to resist the soil pressures.

With both earth pressures, the high cost of the reinforced concrete wall above the 4-foot height reflects the added cost of material and labor for forms.

Possible changes

With ever-changing costs of materials and labor, the costs used in this study will change. However, the cost relationships among the different materials and the different kinds of skilled labor do not shift rapidly. What will change is the techniques used in construction. With the reinforced concrete wall, for example, a different technique, such as the use of a tilt-up wall or a prefabricated wall, could conceivably make the reinforced concrete wall as attractive an alternative as the wood or reinforced concrete masonry walls.

Drying Lumber in The Home Freezer

C. S. WALTERS

A NUMBER of questions about drying wood for the home shop have resulted from the article, "Prevent Warping and Cracking of Wood," which appeared in the Spring, 1973, issue of ILLINOIS RESEARCH.

At present there is no sure-fire, practical, inexpensive way to do the job at home. A dry kiln, such as is used in the lumber industry, is too expensive for most home shops. But, while the average do-it-yourselfer does not have a kiln, he does have a food freezer. The freezer offers a method of drying wood until a better way is found.

Food is now freeze-dried commercially and some tests have been made with lumber. This report describes what happened to four pieces of hardwood lumber that were dried in a small home freezer and a warm room.

How study was done

The species and dimensions of the four pieces of lumber were:

Species	*Dimensions*
White ash	4.4 x 20.0 — 62.2 cm. (1¾" x 7⅞" — 24½")
Bur oak	4.4 x 27.3 — 96.8 cm. (1¾" x 10¾" — 38⅛")
Shumard (red) oak	4.4 x 9.8 — 76.8 cm. (1¾" x 3⅞" — 30¼")
Hard maple	3.3 x 22.2 — 83.5 cm. (1 5/16" x 8¾" — 32⅞")

C. S. Walters is professor of waad technalagy and utilizatian. M. E. Ferris, o graduote student, supplied the lumber for the study.

The boards were obtained in green condition from a southern Illinois sawmill. They were wrapped in plastic film to keep them from drying until they could be brought to the laboratory. The ends of the boards were not coated, although end-coatings are commonly used to prevent splits and end-checks.

For the first 104 days of the seasoning period, the ash and Shumard oak were stored in a food freezer of 0.34 cubic meter (12 cubic feet), at −24° C. (−12° F.). During the next 60 days, they were kept in a room where the temperature was 26° ± 1 C. (79° F.) and the relative humidity was 30± 2 percent. The bur oak and hard maple were seasoned in the freezer for 132 days and in the room for 30 days. If wood is left long enough in the above-specified room conditions, it should eventually reach an equilibrium moisture content of about 6 percent.

Each piece was weighed green and at various intervals during the seasoning. Weighing was done weekly during the first 48 days, then was done semimonthly; the last two weights were taken about a month apart.

At the end of the seasoning period, a small sample was cut from each board; weighed; then oven-dried to constant weight at 105° C. (220° F.). From the weights before and after drying, we not only could calculate moisture content, but also could estimate the ovendry weight of the full-scale board.

For example, the sample from the seasoned ash board weighed 79.27 grams; its ovendry weight was 72.68 grams. Moisture content was calculated this way:

$$\text{M.C., \%} = \frac{\text{Green wt.} - \text{dry wt.}}{\text{Dry wt.}} \times 100$$

$$= \frac{79.27 - 72.68}{72.68} \times 100$$

$$= 9.06\% \text{ moisture content}$$

By using this value and the weight of the seasoned full-scale board (3.8 kilograms or 8.3 pounds), we calculated the predicted ovendry weight (D) of the board:

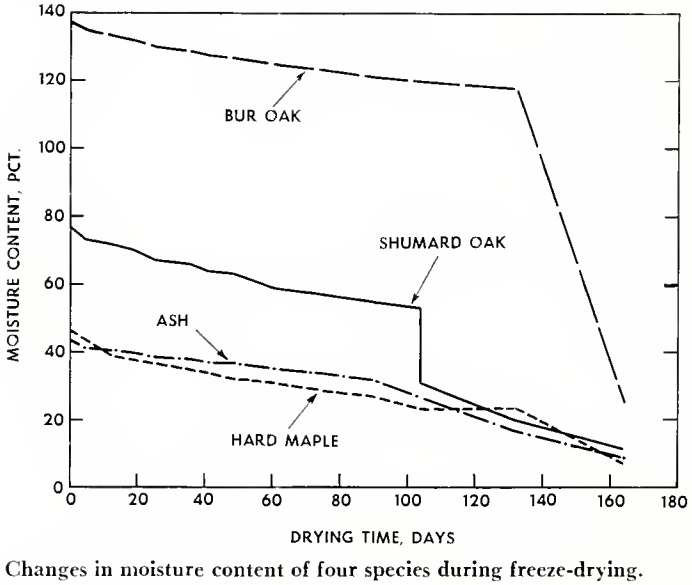
$$0.0906 = \frac{3.8 - D}{D}$$

$$D = 3.4 \text{ kg. } (7.61 \text{ lb.})$$

Knowing the predicted ovendry weight of the board, we could then calculate the moisture content at each of the weights taken during the seasoning period.

Drying is adequate

The graph shows the decrease in moisture content during the 164-day seasoning period. Note the sharp drop after the boards were taken from the freezer and stored in the warm room. Freeze-drying removed the moisture slowly, so there were no



Changes in moisture content of four species during freeze-drying.

Moisture Content of Freeze-Dried Boards

Seasoning time, days	Percent moisture content			
	Ash	Bur oak	Shumard oak	Hard maple
0	43.2	136.9	76.8	46.9
5	41.9	134.8	73.5	43.2
13	40.6	132.6	71.4	39.4
19	39.9	131.3	70.3	38.7
26	38.6	129.6	67.0	37.2
36	38.6	128.3	65.9	34.9
41	37.3	127.5	63.8	34.2
48	36.7	127.0	62.7	32.7
61	35.4	124.9	59.4	31.2
75	34.0	123.2	57.3	28.9
90	32.1	121.5	55.1	27.4
104	31.4*	120.2	52.9*	23.5
132	16.9	117.6*	20.4	23.7*
164	9.1	35.7	11.7	7.2

* Moved from freezer to warm room.

cracks and checks — as would have occurred had the fresh-cut lumber been put directly into the warm room. By the time we removed the lumber from the freezer, it had lost enough moisture that the warm room did not cause any significant harm.

To check whether the seasoning process created internal stresses in the boards that would cause warp, a thin sample was cut from the mid-length of each board. Only the maple exhibited any casehardening, the "geeing and hawing" inside the board that develops from uneven moisture distribution and shrinkage. No attempt was made to relieve the casehardening. Perhaps the hobbyist could have cured the seasoning defect in this particular board by steaming the exterior with a steam iron. With thicker boards, however, it is doubtful that casehardening can be relieved. As a result, such boards would warp when ripped into narrower widths.

As shown in the table, the ash, Shumard oak, and hard maple were dried to less than 12 percent moisture content — dry enough for the hobbyist. The bur oak would have had to season longer, perhaps only a week or so, according to the graph. Lumber with 25 percent moisture content is too wet for bowls, furniture, and other products of the home shop. In Illinois, shop lumber should have no more than 12 percent moisture, and 8 or 9 percent would be better.

According to the results of these tests, 2-inch lumber should be left in the freezer at least 125 days before it is exposed to a warm environment. During that time the frost may build up in the freezer and need to be removed.

The distaff side of the family may not take kindly to using the food freezer to dry lumber for the home shop or using the steam iron to relieve casehardening. However, freeze-drying appears to be a practical way of seasoning small lots of lumber, although it may not be the quickest way.

How Manure Applications Affect Erosion and Runoff

R. W. GUNTHER, W. D. LEMBKE, and J. K. MITCHELL

Soil offers an ideal place for the disposal of animal wastes. Adding manure to the soil completes the cycle of plant material from the land to animals and back to the land. Furthermore, soil microbes have a tremendous capacity to decompose organic materials.

With the intensification of animal production systems in Illinois, large amounts of manure are being applied to ever decreasing areas of soil. This has prompted researchers to study manure application rates and management practices as these affect crop yields, nutrient losses, runoff rates, and soil loss. The laboratory study reported here concerns the effects of manure applications on runoff rates, erosion, and loss of nitrates.

Soil and soil bin

A wooden soil bin 3 feet long, 3 feet wide, and 6 inches deep, was tilted to give a 3-percent slope (see diagram on page 12). In the bottom were ¾ inch of pea gravel, 20-mesh copper screening, and holes to allow for drainage into the percolate collection bottle. At the downslope end of the bin a metal overflow plate caught the runoff, which next drained into a collection gutter and then into the runoff collection bottle.

Catlin silt loam surface soil was mixed and put into the bin, then was broken down manually with a garden hoe and cleaned of organic debris such as leaves.

Waste and rainfall applications

Liquid hog waste was collected from a mechanically aerated oxidation ditch on the University of Illinois Moorman Farms. It had a total solids content of 3.3 percent and a total nitrogen content of 0.29 percent.

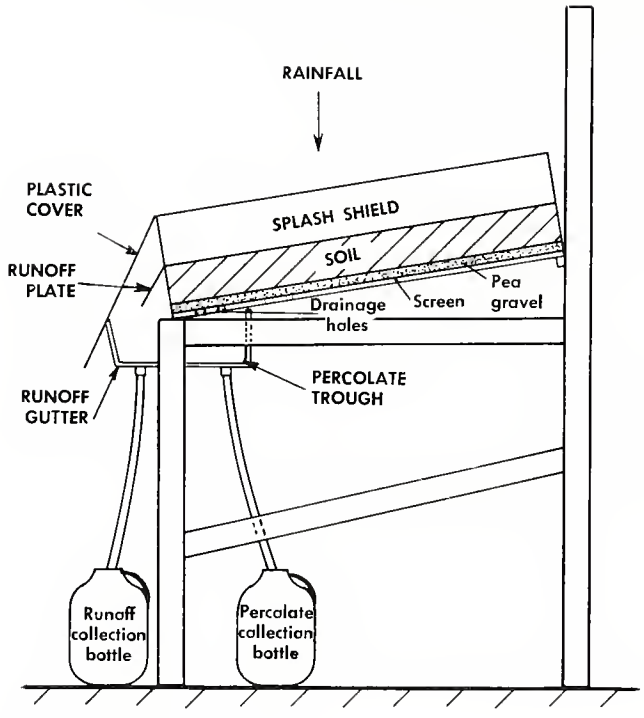
Three treatments were compared: ⅜ inch of liquid waste (1.4 tons of solids per acre) applied to the soil surface; ¾ inch of waste (2.8 tons of solids per acre); no manure, but ¾ inch of water added to the soil. The water was applied to reduce the effect of the water in the animal waste when runoff comparisons were made.

After the water or waste was added to the soil, the bin was placed under a heat lamp for 24 hours to simulate a drying period in the field. Next, a rainfall simulator (Illinois Research, Spring, 1974) was used to apply rainfall at a rate of 3 inches per hour for 30 minutes. Duplicate runs were made for each treatment.

Effects on runoff

Waste applications decreased runoff by about 50 percent (see table).

R. W. Gunther is a former graduate assistant; W. D. Lembke is professor and J. K. Mitchell, assistant professor of agricultural engineering. This article is based on Mr. Gunther's M.S. thesis.



Soil bin and collection system.

However, the ¾-inch application did not reduce runoff any more than the ⅜-inch application.

Cracks were observed in the soil surface after waste was applied. These cracks allowed water to infiltrate into the soil surface more readily. As the soil surface cracked, the surface formed by the waste mixture warped and peeled back, further increasing infiltration and percolation of water and reducing surface runoff.

Loss of solids and nitrates

Waste applications reduced the total loss of solids, both because the runoff was smaller and because it contained a lower concentration of solids (see table). This low concentration was in turn due to two things: (1) The waste stabilized the soil surface so that solids were not easily detached. (2) The warped soil surface formed small irregularly shaped clods which blocked the flow of water over the surface, thus reducing its velocity and erosive power. Although 246 pounds of nitrogen per acre was added with ⅜ inch of manure, very little nitrogen was removed as nitrate during runoff and percolation (see table). In fact, the concentration of nitrates was smaller in the runoff from soil receiving the ⅜-inch application than from soil receiving no manure. We therefore concluded that the stabilizing effect previously described reduced the nitrate concentration in the runoff, as well as the solids concentration. No measurements were made of total nitrogen in the runoff or percolate, and it is possible that much of the nitrogen was in forms other than nitrate.

Runoff and Loss of Solids and Nitrates After Aerobic Liquid Manure Applications on Catlin Silt Loam, 3-Percent Slope

Item measured	Manure application		
	None	⅜ in.[a]	¾ in.[b]
Rainfall, in.[c]	1.5	1.5	1.5
Runoff, in.	.63	.29	.30
Percolation, in.	.17	.39	.29
Total solids concentration in runoff, pct.	.90	.69	.66
Total solids loss in runoff, T./A.	.64	.22	.22
NO_3-N concentration in runoff, ppm	6.0	3.1	8.7
NO_3-N loss in runoff, ppm	.90	.18	.60
NO_3-N loss in percolation, ppm	4.2	17.0	15.0

[a] 1.4 tons of solids per acre.
[b] 2.8 tons of solids per acre.
[c] An intensity of 3 inches per hour for one-half hour.

As total nitrogen increased to 492 pounds per acre with the ¾-inch application, the nitrate concentration in the runoff became greater than when no waste was applied. Because of the lower runoff rate, however, the total removal of nitrate was less for the ¾-inch application than for the zero application.

Both levels of manure increased nitrate losses in the percolate. This was due to the solubility of nitrate with its ready transmission in ground water, and also to the greater percolation of water with the manure applications.

Management affects results

The management practices used in the study are important in interpreting results. First of all, waste applications were low in comparison with those on many livestock farms in Illinois today. Secondly, the waste was applied on a fallow soil and followed with 24 hours of drying. Unfortunately, farmers cannot predict such a drying period after an application of liquid manure, and a sudden rainfall on the wet soil surface would certainly result in considerably more loss of nutrients and soil.

Finally, the results of applying manure to frozen soil would be far different. In field tests during 1967, University of Wisconsin researchers applied manure to frozen ground at the rate of 15 tons per acre. Although runoff was reduced, six times as much nitrogen was lost as where no manure was applied.

Considering the above limitations, we can conclude from our study that applying liquid manure to soil can decrease runoff and the associated soil and nutrient loss from a given rainfall. We can also conclude that manure applications increase percolation through the soil. Much of the benefit derived from the liquid manure is due to the stabilization of the soil surface that results from the crust formed during drying.

A Potential For Fowlpox Outbreaks

D. N. TRIPATHY, D. M. SELLS, and L. E. HANSON

With vaccination and good management practices, clinical signs of fowlpox have disappeared from most chicken flocks. As a result, some poultry owners have discontinued vaccination. However, in some flocks, latent fowlpox infections persist unrecognized.

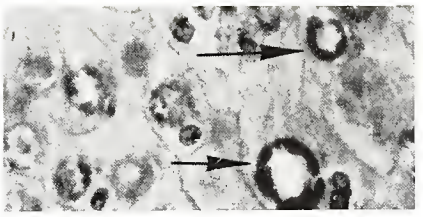
The typical disease

In its typical form, fowlpox in chickens is easy to recognize. Nodular skin lesions develop on various parts of the body, especially the comb, wattle, and legs. Lesions may also occur in the mouth, esophagus, and trachea.

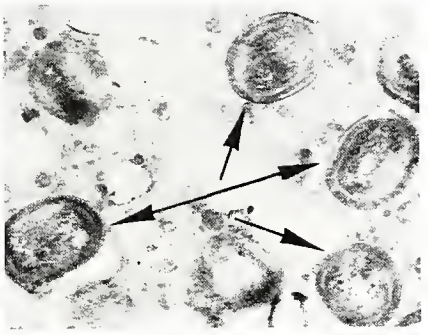
Tracheal infection often causes difficulty in breathing. The lesions are similar to those due to infectious laryngotracheitis virus, which can cause death from suffocation. Mouth or esophageal lesions interfere with the bird's eating. Lesions around the eyes can cause them to close completely.

A diagnosis of fowlpox is confirmed by virus isolation or by microscopic examination of the skin lesions. Growth of fowlpox virus in chicken embryos produces focal or generalized thickened areas on the chorioallantoic membrane which are called pocks. Examination of infected skin or pocks under a microscope shows large virus-containing masses known as inclusions (Fig. 1). Fowlpox virus particles in the inclusions are visible with an electron microscope (Fig. 2).

D. N. Tripathy and D. M. Sells are assistant professors and L. E. Hansan is professor and head, Department of Veterinary Pathology and Hygiene.



Arrows indicate cytoplasmic inclusions of fowlpox virus. (Fig. 1)



Electron micrograph showing individual fowlpox virus particles (arrows). (Fig. 2)

Immune response of vaccinated birds or birds that have recovered from active infection can be detected either by inoculating them with fowlpox virus or by using various serologic or immunologic methods.

Preventive measures include hygienic conditions and regular vaccination. As already mentioned, these measures have greatly reduced clinical cases of fowlpox.

Observations on latent fowlpox

Persistence of fowlpox virus as a latent infection was first reported in 1952 by Duran Reynals and Estelle Bryan. They used methylcholanthrene to induce cancer in apparently normal chicks hatched from eggs in isolation and in adult chickens. Of the birds that were repeatedly treated with methylcholanthrene, 50 to 75 percent developed fowlpox lesions. Virus was not only recovered from these lesions, but was also isolated from some of the control chickens. It can be concluded that the virus was endemic in the parent flocks and in chickens hatched from the breeding flock, which had no clinical signs of disease.

Recently we observed latent fowlpox in chickens from a poultry farm where vaccination against fowlpox had not been conducted for nearly 8 years because there had been no clinical signs of the disease. The birds seemed normal, showing only a few small focal lesions which could be confused with scabs resulting from abrasions. But fowlpox virus was isolated in chicken embryos that had been inoculated with material from these lesions.

When the virus was inoculated in day-old chicks from the same farm, they developed very mild focal lesions of fowlpox without spread of the virus to other skin areas. However, when the virus was inoculated in day-old chicks from another farm, it produced severe skin lesions which spread to comb, wattle, legs, eyes, wings, and often the mouth. The birds' growth was poor and feathering was abnormal.

These results indicated that the chicks from the farm of virus origin had acquired resistance to fowlpox because of persistence of the virus in the parent flock. Chicks from the other farm had not experienced the infection and were fully susceptible.

Later, on the farm of virus origin, the effects of stress on the emergence of fowlpox were noted. Birds stressed by a low-calcium or a low-protein diet did not develop fowlpox lesions. However, fowlpox did appear in some of the birds that had been stressed by withholding feed to induce molting. Skin lesions were extensive on the comb and around the eyes. Fowlpox soon disappeared after the birds were returned to full feed. The stress had lowered the birds' resistance and had caused the latent virus to emerge. Similar observations have been made in California.

Later, on the same farm, infection with Marek's disease virus was diagnosed in some of the chickens. A number of birds showed signs of both fowlpox and Marek's disease viruses. It is postulated that lowered resistance due to a long laying period and Marek's disease infection must have given the latent fowlpox virus an opportunity to emerge.

Controlling Apple Diseases Without Damaging Fruit Set

Preliminary evidence suggests that fungicides should not be applied during full bloom period, as they may interfere with pollen germination

STEPHEN M. RIES

MICROORGANISMS attack all species of plants. The results of pathogen attacks on apples can be loss of yield, defoliation, reduction of crop quality, and weakened trees. The net result is generally a reduced income for the apple producer.

The most prevalent and serious pathogens influencing apple production in Illinois and the diseases they cause are *Venturia inaequalis* (apple scab), *Gymnosporangium* spp. (rusts), *Erwinia amylovora* (fire blight), and *Podosphaera leucotricha* (powdery mildew).

Apple scab damages the leaves, fruit, and fruit pedicels. Pedicel infections during blossoming may cause premature fruit drop. Rust infections on the fruit result in misshapen and unmarketable fruit. The blossom blight phase of fire blight destroys entire fruit clusters. Powdery mildew infections can so weaken a tree that it may fail to bloom in succeeding years. Therefore it is important to control diseases during blossoming, when these pathogens are a potential hazard.

Fruit set

A marketable apple crop is contingent on many factors, including fruit set, as well as insect and disease control. Successful fruit set, in turn, depends upon both internal and external factors.

An internal factor which influences fruit set of the apple is pollen incompatibility. Apples are self-incompatible, because fertilization does not occur if both pollen and ovule are from the same cultivar. Therefore pollen from dehisced anthers of one cultivar must be transferred to stigmas of another receptive cultivar to allow fruit set.

External factors influencing fruit set are generally environmental, and include nutrient supply, pruning habits, plant age and vigor, temperature, light and water relations, bee activity, disease, and harmful insect occurrence.

Fruit set therefore requires two compatible cultivars in close proximity, blooming simultaneously; the presence of bees to transfer pollen between the cultivars; and environmental conditions favoring bloom and bee flight. Pollen grains germinate on receptive stigmas by means of a germ tube (see illustration), which penetrates the stigma, grows down the style, fertilizes the ovule, and results in fruit set. Conditions that influence any of these processes affect the quality and quantity of fruit produced.

Disease development

Disease development on host tissue is similar to the fertilization process described above. A pathogen's propagative unit, usually a fungal spore, is slightly smaller than the pollen grain. It must be deposited on susceptible host tissue under proper environmental conditions, germinate, penetrate the host, and proliferate, to produce disease symptoms. Not only are the processes of fertilization and pathogenesis quite similar; they also often occur at the same time, during the bloom period. Disease development at this time is known to reduce fruit set and thus lower fruit quality.

Disease control on many fruit crops, especially apples, at present depends upon the thorough application of protective fungicides and bactericides. These pesticides are specifically designed to control one or more of the major apple diseases listed above. Their mode of action is to keep the fungal spore from germinating, to prevent penetration by the fungal germ tube, or to prevent bacterial growth.

Toxic side effects

Pesticides are screened by chemical companies and by governmental agencies both for effectiveness and for undesirable side effects on the environment. For example, insecticides are designed to control insect pests such as the codling moth, but some are also known to have undesirable effects on bees and other pol-

Stephen M. Ries is assistant professor of plant pathology.

linating insects, which are commonly called non-targets. Therefore insecticides should not be applied to apple trees during the bloom period.

Similarly, fungicides are screened for effective disease control and for toxicity to leaf tissue, but few have been examined for toxicity to pollen grains, also a non-target. As pointed out earlier, pollen grains and fungal spores are similar in size and germination processes. However, unlike the insecticides, fungicides are currently applied by many apple producers during the bloom period, often at 4- to 10-day intervals. The possibility of a non-target effect on pollen germination was therefore studied in two apple cultivars.

Jonathan apple pollen grains. The pollen is generally triangular in shape with the aspices quite evident on the nongerminated grains. A germ tube is emerging from the pollen grain at lower right.

Pesticide toxicity

Unsprayed apple blossoms were collected from Jonathan and Golden Delicious cultivars in 1974. The pollen was separated from the other floral parts and assayed in the laboratory for the ability to germinate in a sugar solution containing a bactericide or one of several fungicides. The effects on pollen germination varied widely, depending on both the kind and the concentration of pesticide (see table).

Agri-Strep, a bactericide applied at 4-day intervals during bloom to control the fire blight disease, did not significantly interfere with pollen grain germination. However, fungicides, which are applied at 7- to 10-day intervals during bloom, varied widely in their effect on pollen germination. Benlate and sulfur were the least toxic fungicides tested while the dithiocarbamate group of fungicides (Zineb, Polyram, Dikar) were the most toxic. Besides reducing germination, many fungicides also inhibited the rate of growth of the pollen germ tube.

Effect of o Bactericide and of Select Fungicides on Pollen Grain Germination

Pesticide[a]	Rate[b]	Percent germinating pollen[c]	
		Jonathan	Golden Delicious
Control		100	100
Bactericide:			
Agri-Strep 17W	0.042 lb. (50 ppm)	100	96
Agri-Strep 17W	0.084 lb. (100 ppm)	80	88
Fungicides:			
Benlate 50W	0.25 lb.	59	57
Sulfur 95W	2.00 lb.	58	84
Benlate 50W + Superior oil	0.125 lb. + 1.0 qt.	47	78
Sulfur 95W	5.0 lb.	30	70
Cyprex 65W	0.25 lb.	28	21
Cyprex 65W	0.375 lb.	13	20
Cyprex 65W	0.50 lb.	8	12
Captan 50W	2.0 lb.	4	15
Dikar 80W + Triton B1956	2.0 lb. + 3.0 oz.	1	17
Polyram 80W	2.0 lb.	0	7
Zineb 75W	2.0 lb.	0	5

[a] Pesticides are listed in increasing order of toxicity to Jonathan apple pollen.
[b] Amount of formulated product per 100 gallons.
[c] Expressed as percent germination compared to controls.

Integrated management

Fruit growers, aware that insecticides are not specific for the target insect, do not apply these materials during bloom. However, until now the possible effects of fungicides applied during bloom has received little attention.

Preliminary evidence obtained in our experiment suggests that apple producers should consider omitting any fungicide application during the full bloom period when pollen is germinating, or until sufficient fruit set has occurred. An integrated spray program can be developed that will not include any spray other than streptomycin (a bactericide) during full bloom. Fungicide sprays at full pink and again at petal fall should give adequate disease control, maximum fruit set, high yield, and a quality product.

The continued evaluation and selection of fungicides should include pollen toxicity studies. The potential reduction in yield as a result of damage may also occur in other fruit crops such as pears, strawberries, and peaches which receive fungicide applications during the period of pollination. In future experiments we hope to expand these research efforts to field studies where measurements on yield can be made.

Aging of Bull Spermatozoa During Extended Storage

R. E. BEIL and C. N. GRAVES

A CLUE to the phenomenon of aging may be found in recent studies of changes in bull spermatozoa during storage.

If the spermatozoa are stored a long time before being used for artificial insemination, they lose some of their fertilizing capacity. This occurs at storage temperatures as low as −196° C., where the activity of most enzymes ceases.

Even if eggs are fertilized by the aged spermatozoa, embryos often do not survive. When cows inseminated with these spermatozoa are determined to be pregnant 30, 60, or 90 days later, many of them return to estrus 180 to 200 days after insemination.

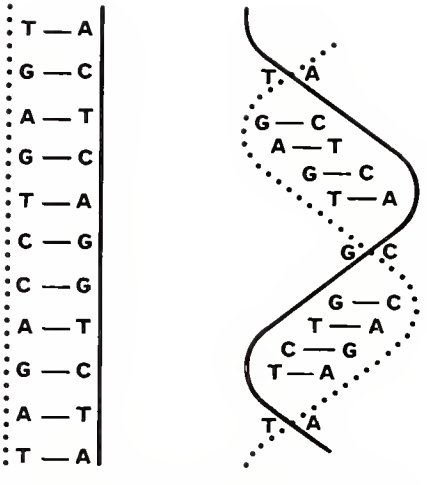
Since these stored spermatozoa are capable of fertilizing the ovum and promoting the development of the embryo at least partly through its term, it was hypothesized that some aging process occurs during storage which damages the nucleus of the sperm cell.

Changes in DNA

Current biochemical studies in the Department of Dairy Science have shown that changes do indeed occur in the nuclear material of spermatozoa during storage. The function of the spermatozoon is, of course, to donate to the egg the paternal half of the embryonic genome. The genetic material carried by the sperm is deoxyribonucleic acid (DNA). It is a large molecule composed of four small building blocks called nucleotides. These are deoxyguanylic acid (G), deoxycytidylic acid (C), deoxyadenylic acid (A), and deoxythymidylic acid (T).

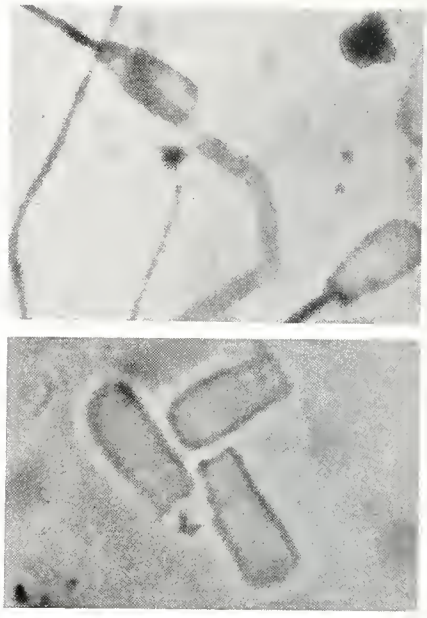
The genetic language is set by the sequence of the nucleotides in the DNA molecule. They in turn join to form two separate long strands which are held together by electrical charges between the nucleotides (Fig. 1). These nucleotides do not pair randomly; A always combines with T while G always combines with C. The double-stranded DNA molecule in turn twists on itself to form a helical structure which resembles a spiral stairway (Fig. 1).

The DNA of all animal cells is associated with protein to form a complex called chromatin. Although the chromatin of most cells contains many kinds of protein, bull sperm cell chromatin contains just one kind. This protein in turn contains many sulfhydryl groups which covalently bind to similar groups on adjacent protein molecules, forming disulfide bridges. As the bridges form, the spermatozoan nucleus condenses, packaging the DNA.



Nucleotides pair to form DNA molecules (*left*). At right the molecule twists to form a double helix. (Fig. 1)

R. E. Beil is a former research assistant; C. N. Graves is associate professor, Department of Dairy Science. This article is based on Mr. Beil's Ph.D. thesis.



Spermatozoa before exposure to DTT/SDS (*top*) and after 30 minutes' exposure (*bottom*). Magnification 1000 X. (Fig. 2)

After the spermatozoon penetrates the ovum, enzymes within the ovum's cytoplasm cause the sperm nuclear protein to separate from the DNA. The freed DNA is then incorporated into the zygote nucleus.

Sperm chromatin studied

Previous research has shown no detectable changes in the quality or quantity of sperm cell DNA during storage. Thus we approached the problem of sperm aging by examining the chromatin complex of bull spermatozoa. If the protein of chromatin should be bound more tightly to DNA during storage, the protein could be more difficult to remove, and thus provide a potential for error once the sperm DNA is incorporated into the embryonic genome. Indeed, our thesis could explain abnormalities that other workers have observed in fertilization from aged spermatozoa.

To test the stability of spermatozoan DNA as a function of gamete age, we utilized the observation that when DNA in solution is heated, it "melts" (changes from a double-stranded molecule into two single-stranded molecules). In solutions of

Table 1. — Thermal Characteristics of DNA Extracted From Stored Bull Spermatozoa

Days of storage	Melting temp., °C.		Pct. increased ultraviolet absorption	
	Before protease	After protease	Before protease	After protease
5° C. storage temperature				
0	51.23	50.75	37.91	38.84
3	51.81	...	35.76	...
8	52.97	51.10	33.46	39.16
15	53.05	...	33.37	...
23° C. storage temperature				
0	50.94	...	36.82	...
3	52.17	...	33.15	...
6	52.25	...	33.71	...

Table 2. — Effect of DTT/SDS on Expansion of Sperm Chromatin

Exposure to DTT/SDS	Days stored		
	0	3	6
	head area, microns²		
None	30.88	30.60	30.73
30 min.	47.41	41.79	43.34

low salt concentration, the protein associated with DNA increases the melting temperature. This increase can be due either to a greater quantity of protein associated with DNA or to a tighter binding of a constant amount of protein to DNA.

The melting point of DNA is found by passing ultraviolet light through the DNA-containing solution during heating. DNA absorbs ultraviolet light and the amount of absorption can be determined instrumentally. Since single-stranded DNA absorbs more ultraviolet light than does double-stranded DNA, the temperature range during which absorption increases indicates the melting point.

We determined the melting points of DNAs extracted from spermatozoa that had been stored for various periods at either 5° C. (41° F.) or 23° C. (78° F.). The melting point of DNA increased with age of spermatozoa during the early days of storage (Table 1). At the same time the percent increase in ultraviolet absorption declined. Neither melting point nor ultraviolet absorption changed significantly beyond 8 days of storage at 5° C. or 3 days at 23° C.

We were still uncertain as to whether the changes in melting temperature and ultraviolet absorption could be attributed to protein associated with the solubilized DNA. The intact sperm cell contains about 40 percent protein. When we measured the protein content of the extracted DNA, we found it to be 7 to 8 percent of the total dry weight of the extracts for all sperm ages. Hence the sperm age-related change in thermal characteristics could not be explained by differences in amounts of residual protein.

We next incubated the DNA extracts with protease, a mixture of strong enzymes, which destroys protein. This treatment eliminated sperm age-related differences for both melting point and percent of increased absorption (Table 1). All the above evidence suggested to us that protein binds more tightly to sperm DNA during storage.

Disulfide in chromatin

One mechanism which might bind protein more tightly to DNA is suggested by the high content of sulfhydryl groups in the protein of bull sperm chromatin. It is well established that disulfide bonds form readily in spermatozoan chromatin during maturation of the gamete in the male reproductive tract. We therefore reasoned that the process may continue during *in vitro* storage, forming a more condensed chromatin complex. Consequently, we conducted experiments to test this thesis.

In these studies, we utilized dithiothreitol (DTT), a compound which disrupts disulfide bonds. When spermatozoa are exposed to a solution of DTT and sodium dodecyl sulfate (SDS), the chromatin within the sperm head decondenses, or expands (Fig. 2). The rate of expansion decreases as disulfide content increases.

To determine whether disulfide content changes during storage, we treated spermatozoa of various ages with DTT/SDS. Before exposure to DTT/SDS, spermatozoa stored 0, 3, and 6 days did not differ in head size. After 30 minutes' exposure, however, the chromatin of unstored spermatozoa expanded significantly more than did the chromatin of spermatozoa stored 3 to 6 days at 23° C. (Table 2).

We infer from the above results that disulfide bonds do form during *in vitro* sperm storage. It is a real possibility that the increase in disulfide linkages could cause the age-related changes in melting characteristics of sperm DNA.

Implications

The results of these studies are strong evidence that, during storage of bull spermatozoa, the protein and DNA in the sperm chromatin become more tightly bound to each other. The intermolecular formation of disulfide bonds apparently mediates the increased binding.

It is interesting that changes in thermal characteristics similar to those presented here have been observed for other tissues in aging animals and have also been associated with a tighter binding interaction for chromatin protein and DNA. This tighter interaction of chromatin components thus may be a universal characteristic of aging.

With a more tightly bound chromatin complex, removal of protein from the sperm DNA in the cytoplasm of the egg could become more difficult. This difficulty could in turn lead to difficulties for incorporation or for gene expression once incorporation occurs.

In future experiments, methods should be tested for inhibiting the binding interaction between sperm chromatin protein and DNA during storage. Reagents known to inhibit disulfide formation can be added to semen diluents and their effect on sperm biochemistry during storage can be tested. Research on the aging spermatozoon may open avenues of research into the aging phenomenon in whole animals.

A Wild Relative of the Soybean

Of the nine currently known species in the Glycine genus, the most unusual is G. falcata, a native of Australia

THEODORE HYMOWITZ and CHRISTINE NEWELL

(*Above*) Distribution of *Glycine falcata* in Australia. (Fig. 1)

(*Right*) Underground single-seeded pods of *G. falcata.* Arrows point to nodules on the roots. (Fig. 2)

Several hundred thousand different kinds of plants are recognized in the world today. Taxonomists have classified and arranged all known plants so as to group those that are most closely related.

Each recognizable kind of plant is called a species (plural, species), which is the basic unit of plant classification. A species is often defined as a group of plants that normally breed freely among themselves. Most species, like the soybean, are represented by millions of individual plants. Although no two soybean plants are exactly the same, they are alike in their essential characters such as flower structure, type of foliage, chemical composition of seed, and growth habit.

Species in *Glycine* genus

Currently soybeans and eight other species are grouped together and constitute the genus *Glycine*. To distinguish the annual cultivated soybean and its eight relatives from one another, a binomial system is utilized. For example, the scientific name of the soybean is *Glycine max*. *Glycine* alone refers to the soybean genus, while *max* refers to the species. The species in the genus *Glycine*, their chromosome numbers, and geographical distribution are shown in Table 1.

Characteristics of *G. falcata*

The most unusual member of the genus is *Glycine falcata*, a wild perennial species indigenous to the dry regions of Australia. It spreads and multiplies both by rhizomes bearing underground single-seeded pods (Fig. 2), and by multi-seeded above-

Theodore Hymowitz is associate professor of plant genetics and Christine Newell is research assaciate, bath in the Department of Agranomy.

ground pods like those of the soybean. Under greenhouse conditions, only a few seed a year are produced on the rhizomes. The seed in the multi-seeded pods of *G. falcata* are about one-tenth the size of seed of U.S. soybean varieties and have a roughly rectangular shape (Figs. 3 and 4).

Another unusual morphological character of *G. falcata* is the position of the middle or terminal leaflet of the three leaflets that make up the leaf. In soybeans, the terminal leaflet is inserted on a small stalk. The leaves are said to be pinnately trifoliolate. However, in *G. falcata* all three leaflets are equidistant from each other, arising from a common leaf stalk. This type of leaf is said to be digitately trifoliolate (Fig. 5).

Table 1. — Chromosome Number and Geographic Distribution of Species in the Genus Glycine

Species	Diploid chromosome number	Distribution
G. clandestina	40	Australia; South Pacific islands
G. falcata	40	Australia
G. latrobeana	..	Australia
G. canescens	40	Australia
G. tabacina	80	Australia; South China; Taiwan; South Pacific islands
G. tamentella	40,80	Australia; South China; Taiwan; Philippines
G. wightii	22,44	Mainly Africa
G. soja	40	China; Taiwan; Japan; Korea
G. max	40	The cultivated soybean

Table 2. — Comparison of Seed Protein, Oil, and Fatty Acid Content of G. falcata and G. max

Chemical component	*G falcata*[a]	*G max*[b]
Protein, pct.	32.4	41.0
Oil, pct.	13.7	21.0
Fatty acids in 100 gm. seed:		
Palmitic, gm.	2.7	3.2
Stearic, gm.	1.7	0.8
Oleic, gm.	2.3	5.0
Linoleic, gm.	5.0	10.3
Linolenic, gm.	2.0	1.7

[a] Plant Introduction 246591.
[b] Average values for U.S. soybean varieties.

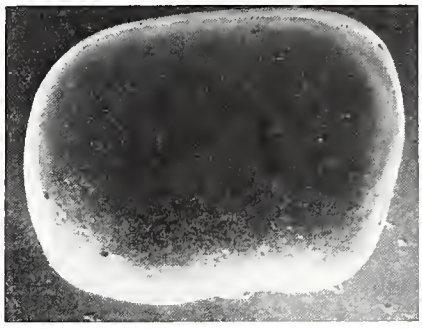
Soybeans are short-day plants; that is, in Illinois they normally flower and produce seed from July to October, when days are getting shorter. Under greenhouse conditions in Urbana, plants of *G. falcata* continue to flower and produce seed throughout the year.

Total protein, oil, and fatty acid content of *G. falcata* seed and soybean seed are compared in Table 2. Soybean seed contain more protein, oil, oleic, and linoleic fatty acids than seed of *G. falcata*.

Possible future use

At present *G. falcata* does not appear to have any economic characters immediately useful to soybean breeders. Nevertheless, an understanding of the inheritance of perennialism, rhizome and underground pod formation, digitately trifoliolate leaves, lack of photoperiodic response, and other characteristics, as well as an awareness of the range of variability available in the species related to the soybean, may be useful to future soybean breeders.

Compared with the seed of the soybean variety Cutler 71, shown at right, the seed of ***G. falcata*** is much smaller and is also less rounded. (Fig. 3)



This photograph, taken with a scanning electron microscope, shows up the rectangular shape of ***G. falcata*** seed and the lack of ornamentation on the seedcoat. (Fig. 4)

A flowering specimen of ***G. falcata*** showing the digitately trifoliolate leaflets. (Fig. 5)

FARM BUSINESS TRENDS

THE CATTLE INDUSTRY is a major source of cash receipts for U.S. agriculture. In 1973 receipts from sales of cattle were at an all-time high of $22.4 billion, or 25.8 percent of cash receipts from farm marketings. With the 1974 price decline, receipts from sales of cattle dropped sharply to $17.9 billion, or only 19.1 percent of farm receipts. Although cattle feeding has been declining in Illinois, sales of cattle brought in $629 million in 1973, 12 percent of the state's farm income from sales of farm products.

In recent years the cattle and beef industry has had its problems. Consumers expressed concern about beef prices. Later government price controls, which included beef, disrupted the entire industry. High grain prices in 1974 made cattle feeding unprofitable.

There have also been long-run changes in the industry.

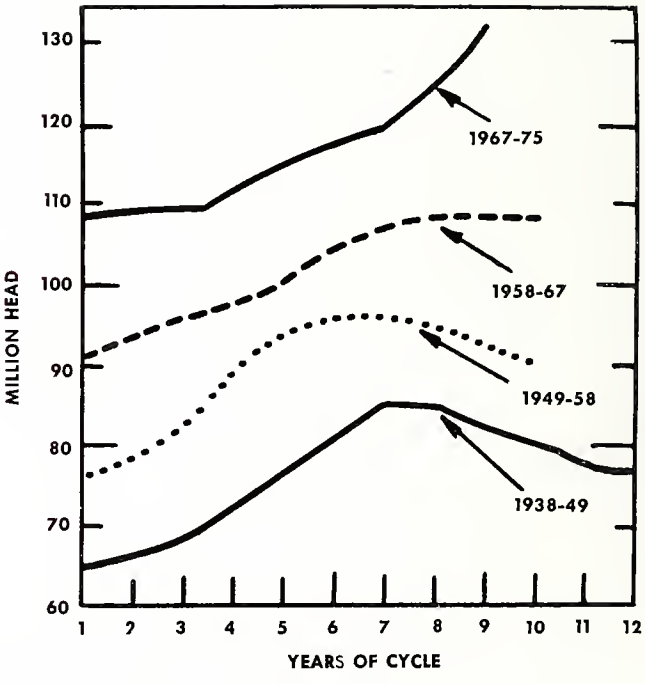
Per capita consumption of beef has steadily increased. And, until last year, our expanding grain supply made feeding profitable. Much of the increased feed supply came in the southwest and plains states, where irrigation and hybrid sorghum greatly expanded the production of grain sorghum. More than two-thirds of this crop is fed to beef cattle.

Numbers of fed cattle marketed have increased sharply from 10.7 million head in 1955 to almost 27 million in 1972. With this increase the location of cattle feeding has changed. In 1974 the leading states were Texas, marketing 3.9 million fed cattle; Nebraska, 3.6 million; Iowa, 3.1 million; Kansas, 2.2 million; and California, 2.0 million.

With these changes in location, size of feeding units increased. In 1962 about two-thirds of the cattle were fed in feedlots of less than 1,000 head capacity. By 1974 almost two-thirds of the cattle were marketed from feedlots with a capacity of 1,000 head or more. Almost one-fifth of the fed cattle were marketed from 73 feedlots with a capacity of 32,000 or more.

Despite these changes, we are continuing in a cattle cycle which began in 1967. Cattle cycles usually last 10 to 12 years (see chart). They occur because of the time lag in adjusting to market conditions in the industry. When expansion of cattle herds gets under way, it builds up a momentum that carries cattle numbers higher than the market capacity for beef. When prices drop, cattle are held in hope of better prices, with the build-up sometimes continuing 2 to 4 years after the price break. This time, because of the shortage of feed grain, the adjustment may be more rapid. Cattle inventories will likely be about leveled off this year.

Even with numbers leveled off, beef production will set new per capita records. Whether the cattle industry can be stabilized at this level will depend on future consumer demand and feed supplies. But likely the worst problem for the present cycle may be passed this year. — *M. B. Kirtley, Extension economist, livestock marketing*



Cattle on farms (48 states) by cycles, each cycle beginning with a low in cattle numbers.

University of Illinois at Urbana-Champaign
Agricultural Experiment Station · G. W. Solisbury, Director
Urbana, Ill. 61801 · Publication · 12M

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EXTENSION SERVICE review

U.S. Department
of Agriculture

January
and February
1975

Women - Completing the Extension Team

VOL. 46 NO. 1 JAN. - FEB. 1975

The Extension Service Review is for Extension educators — in County, State, and USDA Extension agencies — to help people learn how to use the newest research findings to bring about a more abundant life for themselves and their communities.

The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through July 1, 1978.

The Review is issued free by law to workers engaged in Extension activities. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, at 40 cents per copy or by subscription at $2.25 a year, domestic, and $2.85, foreign.

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EXTENSION SERVICE
review

Official bi-monthly publication of Cooperative Extension Service; U.S. Department of Agriculture and State Land-Grant Colleges and Universities cooperating.

CONTENTS **Page**

Extension Women in IWY-'75

With this issue of the *Review,* Extension helps celebrate International Women's Year (IWY), 1975, by featuring a few of the many outstanding women who are performing interesting and vital jobs on the CES team today.

The official United Nations symbol for Women's Year on our cover—the stylized dove representing "equality, development, and peace"—will fly above the UN-sponsored conference for IWY in Mexico City this summer.

In the United States, there are plans at all levels, governmental and nongovernmental, for observing this Year. Many Extension homemakers clubs across the Nation have already made plans for special programs based on the Women's Year theme.

IWY offers a unique occasion for groups and individuals to focus on improving the status of women, while recognizing their special achievements and their responsibilities for the future.

The U.S. Center for International Women's Year, funded by the Department of State, has proposed an "IWY Calendar of Months," in which June will honor women in farming and agribusiness.

For information, materials, and ideas for Women's Year activities, groups may address: U.S. Center for IWY, 1630 Crescent Place, N.W., Washington, D.C. 20009.—*Jean Brand*

Completing the Extension Team

by
James E. Lawrence
Associate Professor
Communication Arts
Cornell University

Kathe Brown catches up on office work.

Three score years ago John Barron was employed in Broome County as New York's first agricultural agent. Not long ago, in Allegany County, Kathryn Brown became the State's first woman to serve in a similar position. Both were milestone events, but a historian might have difficulty deciding which was of greater significance to Cooperative Extension.

Talk to "Kathe," and she modestly dismisses her pioneering achievement as part of an institutional growth process. Her point is that Extension reflects the needs and outlooks of people according to the times. Therefore, the fact that women are becoming agricultural agents is part of an idea whose time is now.

"Extension," she explains, "is noted for people pulling together. It's a matter of teamwork. Women joining the ranks of agricultural agents add a new dimension that further completes the Extension team."

Kathe contends that being in the forefront of this movement does not necessarily symbolize the breaking of so-called chauvinistic barriers. She suspects that few if any women have ever been turned down for a job in agricultural extension work. "Probably in the past," she speculates, "no women came along with the interest and training in this challenging and rewarding field."

"Fortunately, I happened to be in the right place at the right time with the right qualifications. I would like to believe that I was hired strictly on the basis of what I brought to my job, meaning my credentials and capabilities," she says.

Kathe grew up on a dairy farm that specializes in purebred Holstein-Friesian cattle. The sights and sounds of the farm scene were part of her childhood; plea-

sant memories encouraged her to work toward a career in agriculture. Checkpoints along the way included formal training at the State University's Agricultural and Technical School in Alfred, N.Y.; then Ohio State University; and graduation from the New York State College of Agriculture and Life Sciences at Cornell Univeristy.

"My career expectations, fostered largely by a farm and 4-H background, were always focused on work in agriculture," she notes. "But being a woman imposed a certain degree of haziness as to exactly where and how I might find a job that would dovetail with my experience and training."

She claims that this uncertainty motivated her to study agricultural subjects, emphasizing animal sciences and agricultural journalism. Much of her extracurricular time was devoted to dairy cattle judging, a natural interest that grew out of her owning and showing cattle since she was a youngster.

Graduation from Cornell was followed by a job in agricultural journalism, writing and editing publications for a purebred cattle association. Later she applied for agricultural extension work, and in January 1973, she entered the mainstream of Allegany County agriculture. She advises some 500 commercial dairy farmers on a variety of technical and management subjects.

"It's most rewarding to be able to serve farmers by applying my farm background, college training, and the resources of our Land-grant university, Cornell," she says.

Feedback from the field indicates that Kathe is not only widely accepted among farm families, but that she is highly regarded as a competent professional by her coworkers. Charlie Habblewaite, who recently retired as Allegany's longtime head agricultural agent, says, "Kathe has brought the right combination of skills, talents, and dedication to her job, exactly what we need in agricultural extension."

That new dimension Kathe speaks about could be interpreted as a rededication to the same Cooperative Extension mission that inspired John Barron to pioneer as New York State's first agricultural agent some 60 years ago. Now it is Kathe Brown's turn to pioneer America's agricultural future. □

Farm families in Allegany County, N.Y., receive a variety of technical and management advice and information from agricultural agent Kathe Brown.

Biologist 'Makes Waves' With Sea Studies Program

by
James Leadon
Editor, Oregon State University
Sea Grant Marine Advisory Program

"If you ever want a crowd, offer a program on clams," says Vicki Osis, one of the Sea Grant-Extension Marine Advisory Program's two education specialists in Oregon. She learned that lesson a few months ago. At a Salem "stop" in a series of how-to-do-it talks about clams, the Marion County Extension staff arranged for a room to hold 150 persons. Four hundred came.

Although Vicki and senior education specialist Don Giles are based at the Oregon State University Marine Science Center in Newport, Oregon, that series was one way they have integrated their activities with statewide Extension Service programs.

Vicki has also worked closely with 4-H. She has prepared two manuals for 4-H clubs and she's been busy this summer with the first 4-H Marine Science Camp at Coos Bay, Oregon.

Most often, she can be found at the Marine Science Center (MSC) where things are always busy.

In the fall and winter, Vicki's main concern is the next busload of students. For 2 years, she met almost every bus and conducted the students through the MSC educational displays and aquarium. Since 1973, she has had the help of two OSU interns and other volunteers. She now has more time to work directly with teachers.

Vicki has participated in four Saturday workshops for teachers at the Center and conducted a 2-day workshop in Bend for teachers who cannot make it to the coast.

She helps teachers recruit and train volunteers (frequently retired persons) to accompany school tours to the MSC from their own communities. She now has 20 volunteers on file.

Vicki is also responsible for converting a former Coast Guard building into a laboratory for students and youth groups. A lot of planning went into the Yaquina Head Lighthouse Program, which can accommodate 30 students at a time on a year-round basis.

What brought Vicki to Oregon? A course in invertebrate zoology which she needed for her master's degree in zoology from the University of Missouri. OSU's Newport marine lab was her choice.

That was 1967. She was back again the next summer as a research assistant. Vicki started full-time with the Extension Service at the MSC in the fall of 1971—"one of those 'temporary' jobs that have a way of becoming permanent," she says.

Looking ahead, Vicki plans a basic library of marine science teaching materials. Television is an increasingly important educational tool: she recently produced a series entitled "Making Waves" for school use.

"Helping youth discover the sea" is a basic goal for Vicki. She's never had to search for potential discoverers.□

Junior High students from Corvallis ask Vicki Osis questions for "Making Waves," a five-program series on ocean life.

Once 'They Wouldn't Accept A Woman'

by
David A. Zarkin
Information Specialist
Agricultural Extension Service
University of Minnesota

"What can I do about these crabgrass weeds?" the frustrated home gardener asks.

"I need to know how to germinate apple seeds, for a paper I am writing in my biology class," the high school student writes.

They call the horticultural clinic at the University of Minnesota's St. Paul campus and speak to Extension Horticulturist Jane Price McKinnon or one of her energetic student staffers, who field about 36,000 inquiries during the growing season. Many gardeners send post cards and letters. Most questions deal with shade and ornamental trees, indoor plants, flowers, vegetables, and turf.

Jane McKinnon feels lucky to be in the hot seat as an ever-increasing number of home gardeners find her telephone number. "I was extremely lucky to have been able to pursue an interest in horticulture by being admitted in the first

Jane McKinnon, second from the left, discusses gardening problems with students and staff.

place to the University of Minnesota Graduate School, and then to be invited to do this job when it was created in 1970," Ms. McKinnon said.

She comes from an Extension background. Her father, James H. Price, was a county agent for about 40 years in Mississippi. She gardened in the South before coming to Minnesota.

Jane does not claim to be a walking encyclopedia on gardening, but she has resources at hand at the University to find answers to most questions that come to the horticultural clinic, which was established by the Minnesota Agricultural Extension Service.

Backyard gardening definitely is on the upswing in metropolitan Minneapolis-St. Paul, as it is throughout the Nation. The University is located in the center of almost 2 million metropolitan residents. Ninety percent of households in this area have some kind of plant material.

"The University has a long tradition of interest in and interest from home gardeners. The challenges of the northern climate had given us decades of experimentation in plants and their cultures from fruit trees to watermelon varieties.

"To cite an example of gardening interest, the 108-year-old Minnesota State Horticultural Society, whose membership is mostly home gardeners, is one of the largest in the Nation and works closely with the University," she added.

With its highly visible experimentation plots, new greenhouses, and modern building devoted to horticultural science, the St. Paul campus became the logical place for metropolitan gardeners to seek information. Although many more gardeners are contacting Extension agents in the metropolitan area, calls to the campus continue to increase. Minnesota Extension specialists are long accustomed to dealing with growers and cattle producers, but the increasing demand from amateur gardeners had become overwhelming.

The University has a long record of serving Minnesota home gardeners, even before the clinic began operating in 1970. Extension Horticulturist Orrin C. Turnquist had worked with home vegetable growers for many years, and home gardeners have helped the University test new vegetable varieties. Interest in woody and ornamental plants culminated in the

Checking a foliage problem.

establishment of the University Landscape Aboretum, which serves the home gardener through its research, demonstration, and educational programs, in the suburban Twin Cities. Arboretum Director Leon C. Snyder and Arboretum Horticulturist Mervin Eisel both hold an Extension appointment.

Extension Horticulturist Leonard Hertz assists the clinic on fruit tree problems and Extension Horticulturist Harold Wilkins comes to the clinic's aid on floriculture questions when his expertise is needed. The clinic refers questions and problems to other departments on the campus dealing with insects and diseases, so it is really a multidepartmental activity.

University of Minnesota Agricultural Experiment Station branch facilities throughout the State have test and demonstration plots for flowers, fruits, and vegetables of interest to home gardeners. Extension and Experiment Station staff cooperate on educational programs during field days at the branch stations.

Seeing the need to increase service through the State, Extension Service Director Roland H. Abraham and Associate Director Harlund G. Routhe are strong supporters of the Horticultural Clinic and other programs for Extension horticulture.

Discussing apple varieties.

"It is lucky for me that the climate has changed, allowing a woman to be a horticulturist in a challenging job in an interesting State," Ms. McKinnon said. But luck in only a part of it. Jane McKinnon brings determination, gusto, and compassionate understanding to the task. She has been involved in the Extension Expanded Food and Nutrition (EFNEP) Program with adults and youngsters, where she conducted day-long workshops on vegetables.

She also is interested in teaching 4-H'ers the ecology of Minnesota so that they do not "call all the evergreens Christmas trees." She hopes to give them a sensitivity to the relationship of soils, plants, climate, and scenery so they can enjoy the State's unique environment.

"The first Latin I ever learned was the scientific name of the cucumber beetle that my father helped me memorize when I was 6 years old," she said. She received a bachelor of science degree in 1957 and a master of science degree in 1970, both in horticultural science from the University of Minnesota.

Before accepting her current appointment, Jane worked as a landscape consultant to the University. She has also worked as a landscape nursery designer and served as assistant field director with the American Red Cross.

In the fall of 1970, she spent 6 weeks in Europe studying educational programs in home gardening and methods of teaching appreciation of the environment and horticultural beauty.

Ms. McKinnon says she "cannot resist telling Northern gardeners that one reason they cannot grow peanuts very well is because they do not have a hot tin chicken house roof to dry them on."

It could have turned out differently for Jane McKinnon. Looking back, she quips: "I would have been an entomology student at Mississippi State University in the late 30's, but they wouldn't accept a woman."□

Extension Women Overseas

by
Lyman J. Noordhoff
Information Specialist
International Extension
Extension Service-USDA

Training home economics agents in El Salvador . . . visiting communities in Nicaragua . . . recommending ways to build up 4-T youth work in Vietnam . . . 7 a.m. to 7 p.m. days with no siestas. . . .

These have been typical overseas experiences for CES home economists from Arizona, California, Minnesota, New York, North Carolina, and West Virginia. All were on 1- to 3-month assignments.

All went overseas through the auspices of the Office of International Extension in Extension Service-USDA.

Some of their experiences:

Evelyn Harne, State 4-H staff, Minnesota: She got a firsthand look at 4-T work in Vietnam, where rural youth represent 65-80 percent of all youth. The team visited 18 provinces and three major cities. They gathered facts from 4-T members in villages and from national officials as the base for the 36 recommendations they made.

Betty Rae Weiford, Pocohontas County home economics agent, West Virginia: She was "guinea pig" on a far-reaching professional training exchange. A national home economics supervisor from Nicaragua learned about volunteer leaders during 5 months in West Virginia. She lived and worked with three home economists who trained volunteers.

The next spring during a 6-week study leave, Betty Weiford and her 10-year-old son lived with that supervisor while Ms. Weiford helped her apply the volunteer idea in Nicaragua.

Betty Watson, Stanly County home economist, North Carolina. She and another Nicaraguan national supervisor completed a similar training exchange, concentrating on nutrition.

So inspired was this supervisor, and with a sound command of English from her North Carolina experience, that she applied for and received an $1,800 scholarship from West Virginia University. (State homemakers clubs provided these funds.) Now FAO is sponsoring her at the University of Puerto Rico for her B.S. in Extension. She'll be the only woman in Nicaragua with such training when she returns next June.

In Nicaragua, Betty attended a national women's meeting, where men presided, on guiding homemakers' programs. Later she helped national office agents see the value of having women help with program planning.

Beryl Burt, State 4-H staff, Arizona, who speaks Spanish: During 2 months in Nicaragua in 1971 she helped plan and present a national in-service training conference for Extension home economists and Ministry of Education employees. Educational methods, nutrition information, and lesson plans occupied the first 3 days. The rest of the week Public Health educators taught family planning information.

Beryl observed that the most pressing need was for simple, applied information on nutrition, sanitation, and health.

Christine Groppe, retired nutrition specialist, University of California: "Health and nutrition problems in El Salvador are enormous," she says, "but workers are few."

Her two-stage tour of El Salvador climaxed in a national nutrition workshop. Twenty-six supervisors and local Extenion agents attended, plus persons from six other agencies. Besides much lively learning-by-doing, each received a packet of booklets and visual aids. These 26 women were expected to repeat the workshop for all others in their zones.

What It Takes to Qualify for Extension Work Overseas:

- College degree in Extension-related field
- Extension or similar experience
- Superior references
- Excellent health
- Best-possible fluency in a foreign language. (From their experience, two U.S. Spanish-speakers in this article urge fluency with the language—speak, understand, read, write)
- Limited USDA security check (for 2- or 3-month tours)
- Emotional stability
- Adaptability to another culture
- Deep conviction for service abroad
- Above, all, ability to work as a team member.

If you feel like contributing abroad, ask your state Director or write the Assistant Administrator for International Extension (ES-USDA) for the "Foreign Service Interest Inventory." It simply outlines your abilities and interests, with no commitment.

Or request the new "Sabbatical/Study Leave Interest Inventory." This plan matches those wanting service abroad during leave time with available short-term openings. If you'd like to go overseas for professional improvement, this may be your best choice.

While foreign duty has its trials, those who have served say they feel richly rewarded for assisting those in need. □

'Yankee Traders' Teamup Talent

by
Henry W. Corrow
Extension Editor
University of New Hampshire

A pioneering "trade" of Extension professional talent is benefiting the people of both Rhode Island and New Hampshire. Its success has insured its continuance for 1975. This exchange between two New England States on a long-term, continuing basis may be unique nationally.

Rhode Island has never employed an Extension family life specialist. New Hampshire's Bonnie D. McGee is filling that role.

For several years, New Hampshire has not had a textiles and clothing position. Granite Staters have found an answer in Rhode Island's Helen W. Lundberg.

Extension directors David F. Shontz and Maynard C. Heckel instituted the exchange in the face of monetary restrictions which made it difficult to supply specialist talent in each field in both States.

The innovation has brought advantages in Extension staff development.

Helen Lundberg reports she's gained a fresh outlook on Extension activities in her home State by observing similar endeavors in New Hampshire. A new commitment and involvement in another location has, she says, served "to stretch and refresh the mind."

Then there's the opportunity of learning about people whose needs differ somewhat from those in Rhode Island, and the chance of "sending" ideas and suggestions to a new professional audience while receiving new ideas and suggestions in return.

Ms. Lundberg points out the value of getting more mileage from educational

programs that normally would be presented only once. Now these are given several times to different audiences, and are refined with repetition.

Even the "exhilaration of meeting new people and viewing some magnificent scenery" must be considered in the life of a busy Extension educator, Helen concludes.

Bonnie McGee echoes these observations. "Although the subject matter needs are basically the same in both States, the fact that Rhode Island has never had a specialist in the family life field is, in itself, refreshing and rewarding," she says. "Both the professional staff and clientele are open to suggestions and are willing to explore new programs."

That scarce commodity, objectivity, is another "plus," says the New Hampshire specialist. She has found it stimulating to compare the differences and likenesses in programming and public contacts in both States.

Conferences with Extension staff members have become more intense and productive, since the visiting specialist is utilized to the fullest on her out-of-state visits. Her extension contacts are aware she will not be back for several months and will not be personally carrying out leader training in the counties. But there's always a conference followup if county home economists come up with new ideas or questions.

The two specialists are not the only enthusiasts about the two-state "switch."

Roberta Dix of East Greenwich, home economist for the Southern Rhode Island District, has had formal experience with family life education. Since Bonnie came on the job, Roberta "feels more certain about ways to give advice in 'black and white' programs involving interracial groups." She sees an increase in staff confidence in handling human and child development concerns. There's improved ability of Extension educators "to slip these into existing programs such as those for volunteer 4-H leaders, and with aides in the Expanded Food and Nutrition Project."

Roberta finds that Bonnie has helped home economists "see where they are in terms of professional competence and has helped them teach others to help even larger groups." Contact with the New Hampshire specialist has given county staff tips for working with varied socioeconomic groups. It has helped them realize that home economics programs should not be carried on "separately" but that interstaff cooperation gets the best results.

Marlene Murphy, home economist in the Northern Rhode Island District's Greenville office, had her interest piqued by Bonnie's "Events a la Carte" minicourse. She says "The more I present programs, the more I see that the hidden agenda of those attending is always the subject of 'my family, my husband, my daughter, etc.' " Consequently, both Marlene Murphy and Roberta Dix set up programs dealing with changing family values and attitudes as they relate to the "communication breakdown" in the home.

In New Hampshire, the Extension colleague from Rhode Island has been particularly helpful in supplying sources of information for both staff and leaders, according to Dorothy Wood, a home economist for Hillsboro County, headquartered in Milford, N.H. In a quarterly newsletter to agents, Ms. Lundberg gives tips on techniques. She's conscientious in answering their questions by mail or by phone.

Training she's given in statewide and area meetings has centered around such topics as "finding yourself in fashion," laundering and cleaning methods, and the use and care of new fabrics. For added assistance on construction methods, Ms. Lundberg arranges for a commercial representative to take part. Ms. Wood (New Hampshire) looks forward to instruction (projected for 1975) on deciding whether to make or buy garments, as particularly valuable for her homemaker clients.

Both Helen and Bonnie feel that the exchange of teaching talent is especially appropriate for New England States. There the compact size and similar clientele needs make it easier for small staffs to collaborate to get the most value from personnel and planning.

Administratively, the exchange has brought favorable comments. President Thomas N. Bonner of the University of New Hampshire, in a letter to N.H. Extension Director Heckel, noted a recent "Durham Declaration" which pledged the efforts of the six New England Land-grant presidents to renewed mutual assistance. Said Bonner, "The real success (of the declaration) must come from the efforts of many people like yourself who have caught the spirit of state service and regional cooperation."□

Inspecting papaya.

A 'First' For The Fiftieth

by
Anita Povich
Information Specialist
Cooperative Extension Service
University of Hawaii

"If I were a farmer and a young 'chick' came out in the field to diagnose problems, I'd weigh my 20 years' experience against her few years in school and probably do it my own way. I know I'm still on trial and it'll take a while before they use our University recommendations," says Dr. A.M. Alvarez.

Fascinated by the many obstacles that the land presents to farmers in South America, Anne Maino Alvarez learned her tropical plant diseases firsthand while exploring the Amazon, studying bacterial diseases of beans in Costa Rica, and teaching plant pathology at the University of Neuquen in southern Argentina.

This past year has found Anne exploring new lands, specifically the weathered tops of oceanic volcanoes that make up the chain of Hawaiian Islands. As Extension plant pathologist for the University of Hawaii College of Tropical Agriculture, Anne is not only CES's first female plant pathologist, but the first in Hawaii's Plant Disease Clinic, which diagnoses and prescribes treatment for Hawaii's disease-ridden plants and vegetables, spotting potential problem areas before the diseases "get out of hand."

Agricultural producers and homeowners are encouraged to bring in samples of diseased plants, and they do, turning the clinic into a familiar gathering place for plant-problem people. By collecting as many representative samples as possible, the College feels that the clinic can keep an eye on the biological phenomena that may have an impact on the State.

The clinic normally receives most of the samples from growers through Extension county agents working in the field on all the islands. Samples include orchids, anthuriums, taro, and dasheen from Hilo; papaya from the Puna district of Hawaii; won bok from Kamuela; carnations, cabbages, tomatoes, and onions from the Kula district of Maui; eggplant and bell pepper from Kauai. Field corn and sorghum come from Molokai, and ginger and Manoa lettuce from Oahu.

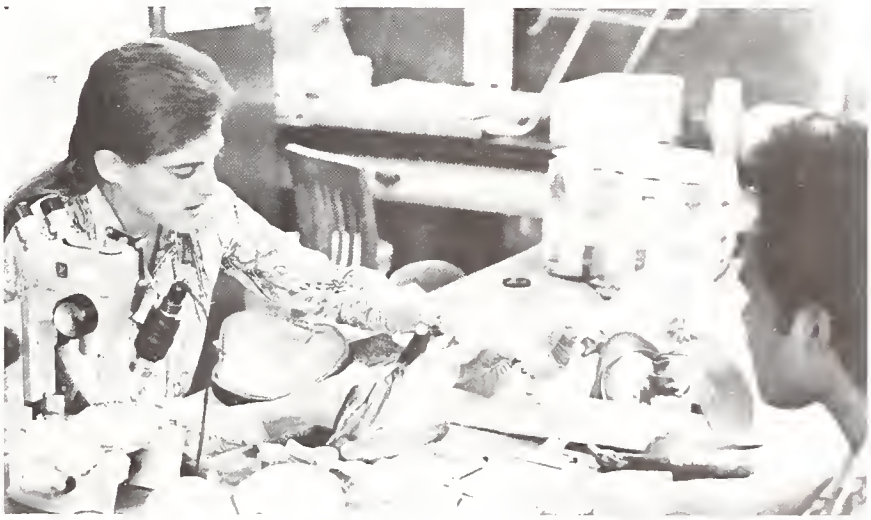
Anne works with Albert P. Martinez, Extension specialist in plant pathology, who started the clinic in 1967 and pioneered its growth in Hawaii to a present caseload of 2,600 samples per year. The two also make on-site farm visits when necessary, given their limited travel budget and the ocean to cross each time they visit either Kauai, Molokai, Lanai, Maui, or the Big Island of Hawaii. (The University of Hawaii and the Plant Disease Clinic are located on Oahu.)

Armed with her knife, magnifying lens, and machete, Anne is becoming a familiar figure to Hawaiian farmers, who have seen her climb ladders, wade rivers, or hike on a mountainside to reach a problem area.

When asked if she ever encounters resistance from farmers, Anne replied, "I've had good cooperation. I found that farmers in Hawaii have a marvelous sense of humor and are quite receptive to seeing new 'creatures' in the field. I also know, however, that I'm on trial, that it will take time for many of the farmers to accept our recommendations."

Anne stresses that most diversified agriculture in Hawaii is at the family level. "Farms are small, less than 10 acres, and use intensive hand labor. Also, because of our beautiful year-round climate (the average temperature is 72°), we also have year-round plant diseases—and Hawaii's diseases are plentiful. For example, papaya, a tropical fruit popular both in Hawaii and Japan, raises problems of fruit rots, root rots, postharvest diseases, and some viruses.

Looking for tropical plant diseases.



Anne Alvarez points out cucumber mosaic virus to a student in the Plant Disease Clinic.

"We recognize most of the diseases," Anne explains, "so we are also involved with fungicide trials with farmers on all islands to determine the most effective forms of disease control and to establish chemical clearance for them."

As part of her Extension responsibilities, Anne trains foremen for ranches and agricultural corporations to recognize diseases. With 80 percent Extension and 20 percent research responsibilities, she also handles special problems, such as seed transmission, cultural practices, and epidemiology.

In addition to clinical work and her special research on bacterial plant pathogens, Anne is also part of a new team project launched in November of 1974 on the tiny island of Molokai. The purpose of the project is to set up onion plots on the island to increase the production and quality of vegetable farming.

"This is an attempt to help diversify agriculture in anticipation of the closing down of sugar and pineapple operations. We're doing the same thing with tomato farmers on Maui," Anne says proudly. "It's a combined effort to put into effect the recommendations of University researchers in a practical setting."

Anne received her B.A. in biology from Stanford University and her M.S. and Ph.D. in plant pathology from the University of California at Berkeley. "I didn't go straight through school, however," Anne recalls. "Each time I earned a degree, I'd try to work on diseases in the field in Latin America, but I found that I had to go back to the books again and again." In between her formal classroom training, Anne worked with agronomists in Ecuador, Peru, and Brazil. In Costa Rica she worked with a plant pathologist with the International Institute for Tropical Agriculture.

From classroom to field to classroom again proved to be an excellent training ground for Anne. Working as an Extension specialist has given her the chance to balance laboratory work with field inspections and has given Extension the chance to increase service in the Plant Disease Clinic while expanding the interplay between farmer and researcher.

Already noted for its many contributions to solving the State and the world's tropical disease problems, the College is further enjoying its reputation as an innovator in hiring a qualified woman for field work—an area traditionally reserved for men. □

With a staff member, Anne Alvarez (right) looks for signs of stem end rot in a new variety of papaya.

Rebecca Detects Diet Effects on Diabetes

by
Richard D. Van Brackle
Assistant Extension Editor
University of Arkansas

It started out as a fairly simple 4-H project for Rebecca Taylor. It now sounds very much like a hospital's pathology study: "The Determination of the Effect of Diet on the pH, Protein, Glucose, Ketones, and Blood Content of the Urine."

Ms. Taylor, the 16-year-old daughter of the Howarth Taylors of Hickory Ridge, Ark., started her health project in 1971. Then it was called "The Determination of Glucose in the Urine in Screening for Juvenile Diabetes." She very quickly involved her classmates and students in the entire school district.

As a student, Rebecca had found out how serious diabetes is in young people. A 30-year-old friend was blind—a result of diabetes when she was 15; a classmate was diabetic and gave herself her own insulin shots; and the school nurse was a diabetic.

Gail Wiederkehr, the county home economics extension agent who has worked closely with her, says that Rebecca screened the Cross County High School; the next year, she covered School District 7, including the high school and three elementary schools.

At first, the other students were greatly amused; the next year, they were much more serious.

Other than being a "pretty good" 4-H project, does it mean anything? Indeed it does. Most of all, the students are all now aware of the seriousness of undetected diabetes among young people. Of the hundreds of students tested, 11 were retested; two were sent for further tests; and parents of eight students were notified of their child's diabetic symptoms and requested to have the child rechecked and watched closely.

Rebecca has received guidance in her project from the school nurse and from Ms. Wiederkehr and, especially with the younger children, received permission from parents.

In her current study, an outgrowth of the urine check for diabetes, she has worked with 59 volunteers at the high school and has run 257 tests during a 2-week period. She hopes to expand her study to other schools, and wants to carry out further tests in regard to urine components.

Some of her findings to date include:

1. Urine pH greatly depends upon the type of diet that is eaten. High protein, high carbohydrate, and starvation diets give an acid urine, while a vegetable diet gives a basic urine.

2. A high protein diet causes protein to show up in the urine in more than normal amounts.

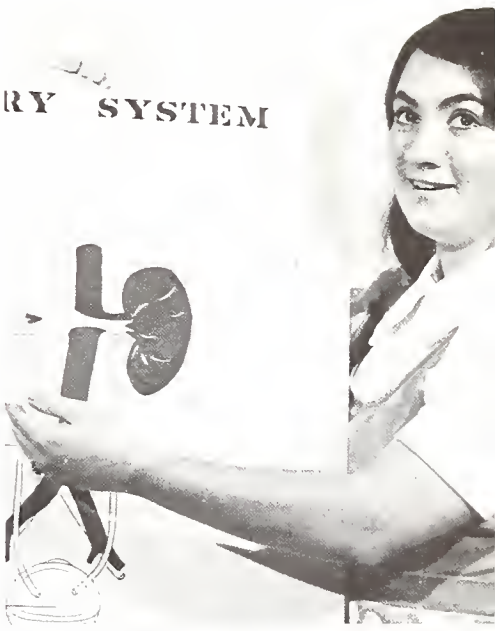
3. Before sugar will spill over in the urine of a normal, healthy, individual, large amounts of carbohydrates, especially sugars, must be ingested.

4. In normal individuals, ketones show up in noticeable amounts only in the urine of those on a starvation diet. This would indicate that ketones are a degradation product of fat metabolism.

5. The presence of blood in the urine can be caused by a pathological condition and is not dependent upon the diet.

For the Taylor family, this has been and will be a growing project. Rebecca's younger brother, Stephen, and sister, Mary, have assisted in the project and plan to carry it on when Rebecca graduates from high school next June.

Rebecca plans a career in medicine. In the near future, she plans to use rabbits, where she can control diets easier, instead of students. She wants to further study the role of diet in the variation of urine constituents. (You can't very well ask a volunteer to go on a starvation diet; a rabbit doesn't have much choice.)



Medical chart helps Rebecca explain effects of diabetes.

Her project has not gone unnoticed. A partial list of awards include: Certificate of Merit from the American Association of Pathologists; Certificate of Award from the Northeast Arkansas Science Fair; second in scientific papers from the Junior Academy of Science; and second place in the State science fair. She is now district and State president of the Junior Academy of Science.

One very young woman has a better chance to enter a career in medicine through an Extension "head start." □

Computer Mystique and Feminine Mystique Join Forces

by
Linda Christensen
Extension Marketing Editor
and
Martha Benn
Student Intern
Ag Communications
Michigan State University

MSU Ag Economist Mary Zehner (left) and Consumer Marketing Specialist Sheila Morley see promise for computerized diet planning for calcium, protein, iron and other nutrients.

Suppose you're not getting all the calcium you need, you can't afford to spend more for food, and you just don't like cottage cheese?

"Synthia," one of Michigan State University's most versatile Extension employees, is ready and willing to help you out.

She's a computer with a woman's voice and has recently been programmed to help upgrade the nutrition of Michigan youngsters, the elderly, expectent mothers, and others.

In the past, Synthia has been employed by farmers, planning nutritious rations for poultry and livestock.

Now, thanks to Sheila Morley, MSU extension consumer marketing agent, and MSU agricultural economists Mary Zehner and S.B. Nott, Synthia ia also programmed to aid in nutrition planning for people.

The program is free, simple, personalized, and meaningful. And it offers a chance to "tinker with a computer."

Synthia accurately measures the lack or excess of nutrients in your diet and makes suggestions for improvement—at acceptable cost and suited to your individual tastes.

"With today's high food prices, we can no longer afford to make 'mistakes' at the grocery store," says Ms. Morley. "We're finding out that people with poor diets tend to overspend on protein foods, such as meat—the most costly part of the diet. That leaves less money for other essentials such as fruits and dairy products."

Most "mistakes" in poor diets include too many meats, eggs, fats, and sugars.

"Synthia's analysis and suggestions don't necessarily mean you spend less on food, but your money will go further toward a nutritionally balanced diet," Ms. Zehner explains.

So far, the computer can measure the amount of calcium in the diet (other nutrient programs are nearly completed), and has been used by senior citizens, junior high students, and expectant mothers.

All you do is fill out a form, listing your diet during the past week, then Extension specialists feed Synthia the data. The result is a personalized computation of the amount of calcium surplus or deficiency.

Why focus on calcium? It's the most abundant nutrient in the body and very likely to be deficient in your diet. Studies show that teenage girls and expectant mothers, in particular, tend to be deficient in calcium. For girls aged 9 and up, there is often a 25-30 percent deficit.

MSU is expanding the program to cover other nutrients, but Synthia has already proven herself.

In one instance, the computer was used to help improve the diets of teenage girls in a program called "Project Open." This is a federally funded summer school program for disadvantaged junior high school girls.

Among the problems Project Open helps the girls tackle is their poor self-image. Since good health is essential to good looks (a big part of your self-image), the project coordinators turned to MSU to help the teenagers upgrade their diets.

"When they filled out the computer sheets and got an initial reading, the girls scored miserably," Ms. Morley says. "About 70 percent of their diets proved deficient in calcium."

Within a couple of months, their diets were improving.

"And we didn't hear it just from the students. When their mothers came in, they told us 'we didn't realize our daughters were low in calcium—now we're making changes.' "

The computer brings authority and a kind of mystique to the business of nutrition. Young people find it fascinating to deal with the computer, especially when it doesn't tell you, "You have to eat broccoli!"

Synthia realizes that not everyone can or will eat certain foods, so she offers alternative sources for the nutrients and the approximate *current* cost of a serving of each.

Instead of one cup of whole milk, for example, you can eat one-sixth of a 9-inch coconut custard pie, or three-fourths cup of rice pudding with raisins and obtain the same amount of calcium. (The chart also shows how you may pay in increased calories.)

People who can't digest certain foods get alternatives. Synthia's list ranges from the usual dairy products—milk, ice cream, and cheese—to broccoli, collards, and turnip greens as calcium sources.

The computer also takes into account the fact that you get about 20 percent of your calcium from "non-prime" sources—foods other than those mentioned above. She figures this in when she computes the amount you need, making the list less cumbersome for you.

"This computer program could mean a real boost in the use of nutritional labeling," says Ms. Zehner. "Product labels aren't going to be useful unless consumers know what to look for. With Synthia's help, people can find out which food groups they're overeating or undereating. Then, they can begin to refer to nutritional labels when shopping, and correct poor eating habits."

Ms. Zehner turned to MSU extension foods and nutrition specialist Portia Morris for help in calculating the quantity of calcium in products and individual nutritional needs. The job was no picnic—after all, how do you calculate cost-per-serving for a bunch of greens, when much of the product is discarded during preparation?

Part of Synthia's success over other computerized diet programs is simplicity—her one-nutrient approach. Another advantage is the individualized approach she uses. Other programs tried to calculate nutrition for the entire family. Unfortunately, that quart of milk in the refrigerator may not always be equally shared.

Synthia's next projects will be iron and protein, which are also problem nutrients. The nutrient list seems endless. But at this point, so do Synthia's capabilities. □

She Came a Long, Long Way

by
Tom McCormick
Associate Extension Editor
University of Vermont

Back in the fifties, when Karin Kristiansson became TV editor, a woman's place was in the home economics department.

But in 1974, a national award for excellence in television—that most modern of media—went to Ms. Kristiansson, Extension video chief at the University of

Karin gets set to zoom in on Dr. Ted Flanagan and young friends for a TV show.

Vermont. The American Association of Agricultural College Editors (AAACE), for the first time, decided to single out its best in television. Producer, writer, and sometime photographer, Karin was the choice for this highly coveted award.

It was the second time she had been honored by her peers. In 1961 Karin received AAACE's top honor, the National Plant Food Institute Award for excellence in communications.

Not bad for a woman who learned English as a second language and joined Extension Service as a secretary.

Born and educated in Sweden, she moved to Canada after World War II, where she did some freelance writing for CBC. Moving first to New York then to Vermont, she found job opportunities limited for writers and became secretary in the Office of Information.

Editor John W. Spaven recognized her talent and drive and gave her a shot at the first vacancy, which happened to be in the embryonic television area. That's all she needed.

With Jack's help on the camera ("I didn't know a thing"), she came on strong, keeping her 15-minute show "Across the Fence" in the popular 1 p.m. time period. This bucked a national trend that slots Extension in the early hours.

How? By staying on top of technological changes and audience trends to give her programs broad support and maximum impact. She also developed specials, pioneered on nighttime ETV with a consumer hotline program, produced spots, raised money, developed liaison with the schools, and sparked the making of a 30-minute movie, "A River of Milk," winner of the national Broadcast Media Award.

In her spare time Karin has served as regional director of AAACE, seen two daughters into college, acquired an additional master's degree herself, and encouraged her husband as he returned to college for a degreee with honors in mathematics.

But one of her proudest moments came when she received the degree of Honorary State Farmer from the Future Farmers of America. This was more than a thoughtful gesture; it was proof that she had achieved her goal of reflecting the full range of agricultural activities.

Karin was determined to make her show part of Extension education, not a rival. She uses television to alert people to new ideas and motivate them to seek more information. She feels it's particularly good at reaching the unreached; a recent survey shows that 30 percent of her viewers make less than $5,000 a year.

Karin admires her AAACE award.

Karin looks for a strong Extension personality who likes to perform, backed by a mixture of slides and live visuals. And as she scripts, she can "see" the show, a knack that helps her focus in on a clear objective for each program.

Like all good television producers, Karin is alert to trends. In education, that means recognizing the key need and supplying the answers. To do this she uses a mixture of Extension specialists and community leaders, broadening the range of her programs.

With Faith Prior, a well-known consumer authority, and ETV personnel, she developed a show that has touched on everything from burial expenses to the ABC's of the energy crisis. Calls come in from all parts of Vermont, frequently tying up the lines.

Karin was one of the first to spot the back-to-the-land mood, lining up a series of specials in addition to her regular program. Frequently she ties this in with young people. This not only gets the subject matter over in easy-to-understand terms, but also shows how Extension helps develop leadership and citizenship.

Typically, she'll block out her programs several weeks ahead, leaving enough flexibility for emergencies. Then she'll line up her performers. As the day nears, she'll have a conference and plan the visuals. When the show is being filmed, Karin likes to be in the control room, the nerve center of the process that ends in our living rooms.

In an emergency, she'll host the show herself. But although she does it with warmth and charm, she prefers to be behind the scenes, guiding instead of starring. She's apt to be writer, producer, booking agent, and photographer.

At least that's the way it is today.

Now on sabbatical to study the new world of TV cassettes, she'll be back next summer with a whole new outlook. Television keeps changing, she firmly believes. To become rigid is to be left behind. □

Debbie advises Connecticut horse owner on animal health.

Debbie's a New Breed Of Aggie

by
Arland Meade
Head, Department of Agricultural Publications
University of Connecticut

"Yesterday I heard a friend of mine calling frantically to her husband: 'Bill, what is SHE doing in our swimming pool?' This family owns three hogs, and one of the 100-pounders had jumped into the family swimming pool."

Deborah King wrote that in a recent Extension newsletter. Becoming involved with pigs in swimming pools is far out, but owners of pigs in many a backyard situation call on "Debbie" for advice.

Debbie became agricultural agent for three southern Connecticut counties last July—the State's first woman agricultural agent.

To get that job, Debbie competed with about 20 qualified applicants. The hiring committee included farmers and a farmer's wife—all of whom believed that Debbie could work with farmers as well as could any of the male candidates.

Not quite 24 years old, Debbie is a no-nonsense agricultural enthusiast, with a list of impressive accomplishments. At the University of Connecticut she won many awards and scholarships before she was graduated *cum laude* in 1973. She'd had a national Block and Bridle scholarship 2 years and scholarships from a garden club and the American Soceity for Animal Science. She did well on livestock and meat judging teams.

During her 10 years as a 4-H member, she won a national horse project scholarship award and other honors. She says the 4-H slogan "To make the best better" is just as applicable to Extension work with adults.

Like other 1973 graduates, Debbie faced the dilemma of "One can get a job if one has experience but how does one get experience if one doesn't have a job?"

She learned that in May that year there would be a temporary opening to teach vocational agriculture in a school some 30 miles from the University. Doing a top job of explaining why she could fill the spot right away, she got that teaching position for May and June—and managed to get her degree, too.

That fall she became a management trainee for a farm cooperative, and at the same time completed requirements for certification to teach vocational agriculture.

After a half year in Extension, Debbie says that this is the career she's wanted—her college career was prologue. What is

she accomplishing as an agricultural agent?

Her present job includes problems in both plant and animal fields. Her first love is for animals, but she does not hesitate to take on plant and soils problems.

Her "boss," field coordinator Greg Curtis, says, "We need an agricultural agent who can and will tackle whatever problem comes up in whatever agricultural field. Debbie is right for this."

Her growing volume of phone calls from people who have learned that she is "on her well-informed toes" is one indication that she's right for the job.

She has organized, promoted, and conducted several well-attended public meetings. Her newsletter topics have included: "A horse needs loving, too," "A tree is a living thing," "A veterinary school for New England," "What are you feeding your horse?" and "Raising a hog."

Debbie inherited no mailing list of livestock owners. She built a list from sources that included: telephone yellow pages listings of dealers in agricultural supplies, riding academies, and the like; feed store proprietors with whom she promptly got acquainted and who readily hand out her fliers and newsletters to customers; notes recorded from her many phone calls; questionnaires at meetings and elsewhere; her ever-conspicuous suggestion box at meetings; newspaper and radio releases; the Humane Soceity; even from people she meets as she rides horseback along the byways. (Not her official mode of travel.)

"I treat my meetings as State meetings," she says. "I make sure that all arrangements are made carefully and that program leaders and films are effective." She enlists publicity support from the State Extension editor and others.

Timeliness is on her mind. "When we announce a meeting we know that the topic is of concern at that time. The right topic for horse owners this year is infectious anemia. And that's the meeting 132 owners attended." Notes in that meeting suggestion box indicated attendees were glad they came and that they want more such Extension meetings.

Debbie always has literature on the topic, at meetings. Often she shows a movie, followed by the featured speaker and discussion. The movie starts promptly at the time the meeting was announced for.

During the summer of '74 there was much public interest in gardens and hogs—the latter mostly in ones or twos in back-lot pens. And always interest in horses. She's observed that horse owners are always wanting to learn more, but that the learning period for pig owners is chiefly during the first couple of weeks.

In late winter and spring, Debbie will emphasize information on trees, vegetables, and other plants.

Horse owners want their programs during late fall and early winter. Debbie observed that often entire families show up at horse-related meetings. Some 4-H age persons have said that they come to the adult meetings because there's a waiting list for the horse 4-H Club and they need to find out something now, not when there's a club opening.

Some Debbie comments:

"When I get a call at the office about a problem where a farm visit offers more help, I get there as quickly as I can.

"There's no such thing as a slow season in Extension. I could put in a 24-hour day.

"In Extension I can be a leader-planner, which fits my nature. In other jobs I've known, others made the decisions and the assignments.

"The work becomes especially satisfying when someone I meet says: 'Oh, you're the one who runs those good horse information meetings over at the Extension Center.' "

Coordinator Greg Curtis says, "At the time of hiring, I was not sure we had made the right choice in selecting this young woman as agricultural agent over some outstanding male applicants. But let me tell you now—we made no mistake with Debbie." □

Discussing feed rations.

Women Conquering A 'New Frontier'

by
Barby Barone
Community Development Specialist
Colorado River Area
University of Arizona

HELP, LWV, AAUW, I&R, RSVP . . . . Sounds like alphabet soup? These are a few organizations that have been affected by the Women's Involvement Program, one of the newest on the Arizona Extension scene. The goal is to promote community improvement by increasing the involvement of women in community development activities.

The Women's Involvement Program meshes closely with the successful community development efforts of Bob Lovan, one of Arizona's eight community development specialists. He and I have program responsibility in a geographic area that is considered "one of the last frontiers of the West." The two-county area (Mohave and Yuma) boasts a growing population of just over 100,000, scattered over 23,000 square miles of some of the world's most rugged desert terrain.

Several parts of the program focus on the expanding role of women in today's society. As elsewhere in the Nation, Arizona women have multiple roles as homemakers, members of the labor force, volunteers, and active citizens. It is important to realize that women are not leaving the home. Rather, they are bringing a broadened awareness of community into the home . . . a resurgence of concern

Barby Barone at City Hall, Yuma, Ariz. With B.A. and M.S. degrees in Political Science from Florida State University, Ms. Barone is the first woman community development specialist in Arizona.

about the quality of life.

The integration of women into the mainstream of the community decision-making process is one foremost objective of the project. Several areas of community concern that have not traditionally had much input from women have been identified.

These include land-use planning, economic development, and municipal incorporation. The program is committed to increasing self-actualization, self-expression, and a sense of power to cause things to happen as women work in their communities.

One of the most exciting outcomes of the program has been the Women's Community Involvement Workshop held in October at the Marine Corps Air Station in Yuma. The idea was generated last March at a roundtable discussion convened to explore the impact that the Women's Involvement Program might have there.

One of the participants, a military wife, spoke of the "military isolate" and pointed out the need for communication and involvement between the military community and the larger community which surrounds it. This concept was transformed into a vehicle for exploring ideas and taking action.

During the workshop, more than 100 women from all sectors of the community—not just the military—interacted with other informed, involved women to learn about such areas of activity as family life, government, community service, education, the military, recreation, the arts, and business.

Women participating felt that their increased awareness and knowledge filled an important need. Following the wrap-up of the day-long session, many were heard saying "next year when we have this workshop . . . ."

We surveyed participants to evaluate their experience and to find their level of community involvement. There will be a periodic survey to determine what impact, if any, the workshop and related activities will have over time. These data will help measure the Women's Involvement Program.

Another program activity assisted the HELP organization in Mohave County. HELP is a group of concerned women who link needs and resources (frequently HELP is the only resource) in the Upper Mohave Valley. During the past year, the Women's Involvement Program worked with HELP in successfully applying for two federal grants. Information and Referral (I&R) and the Retired Senior Volunteer Program (RSVP) are being coordinated by HELP to increase their capacity to serve the community.

One program of the Yuma County League of Women Voters (LWV) is an investigation of the county's planning and zoning efforts. Concurrently, both Bob Lovan and I are developing a planning and zoning citizens involvement project. The League will figure prominently in this project, particularly in generating and disseminating research material—an effective involvement of women in tackling community problems.

Future program plans include the development of information and materials that can be used by Extension nationwide. The original project proposal developed by Dr. Clarence Edmond, State community development leader at the University of Arizona, called for the hiring of a female community development specialist to work with women's groups and organizations in the Colorado River area. This 3-year pilot program, funded by Extension Service-USDA with special needs money, has been underway in western Arizona for about a year.

Following their sisters who helped conquer the "old frontier," these Arizona women are helping solve problems of a "new frontier"—community development.□

people and programs in review

What Direction For Extension In the Next Decade?

"Where do you think the Extension Service is going during the next 10 years?" we asked speakers at the recent annual conference of Extension Service, USDA. Briefly, here's what some of them said:

•**Secretary of Agriculture Earl L. Butz.** The United States supplies about 34 percent of the world's food aid, and food is one of the most powerful tools of the Secretary of State in his foreign policy program today. It is a compliment to the Extension Service that it will continue to be asked to take the leadership in such urgent and timely tasks as "training pesticide applicators in cooperation with the Environmental Protection Agency," and "the USDA Pest Management program." He suggested also that the Extension Service must during the next 10 years find improved ways to assess the value of programs and account for the tax dollars spent.

•**Edwin L. Kirby, administrator, Extension Service, USDA.** We in the Extension Service, as an integral part of the U.S. Department of Agriculture, have a major responsibility to support the policies and missions of the Department. State and local Extension Services are best able to make decisions on local and statewide needs. Expanded efforts will be needed to improve our communication skills to provide up-to-date information on changing conditions. We must help States utilize computers, cassettes, telephone conferences, video tapes, publications, and other methods to more quickly put information to use.

•**Dr. Glen L. Taggart, president, Utah State University.** He stressed these are times of dichotomy. On the one hand more people are demanding more production, and, at the same time, demanding an unspoiled environment. Land-use policies—or lack of them—will become a tremendous force in the decade ahead. Farm population seems to be stabilizing in many areas.

•**Dr. C. Brice Ratchford, president, University of Missouri.** Competition in the field of Extension has sharply increased. It seems that almost every institution, public and private, is involved in what we call extension work today. He suggested that in the next 10 years, extension programs must be relevant, up-to-date, and presented in a professional manner.

•**Dr. George Hyatt, Jr., associate dean and director, North Carolina Agricultural Extension Service.** The Extension Services will need to make more efficient use of their limited internal resources of Extension specialists. Extension workers must explore various means of collaborating with other agencies, organizations, and groups in planning and implementing educational programs.

•**Dr. Roland H. Abraham, director, Cooperative Extension Service, Minnesota.** In these days of concern for food and fiber supply, and in recognition of Extension's past performance and potential further contribution in this area, he concurs with strengthening agriculture as a top priority. He sees difficulty in trying to restrict our efforts in the home economics-family living area by geographical location. In the health education field we will have to obtain the active support of the health professions. —*Ovid Bay*